128846

FINAL DESIGN REPORT

VOLUME II

APPENDIX A - **Design Calculations and Specifications, Groundwater Extraction System, Off-Site Ditches and Site Cover**

APPENDIX B - **Allowable Wet Well Shutdown Period**

APPENDIX C - **Geotechnical Investigation Report**

Summit National Superfund Site
Deerfield Township of Portage County, Ohio

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Summit National Superfund Site
Deerfield Township of Portage County, Ohio

MAY 1993

REF. NO. 2372 (51)

CONESTOGA-ROVERS & ASSOCIATES

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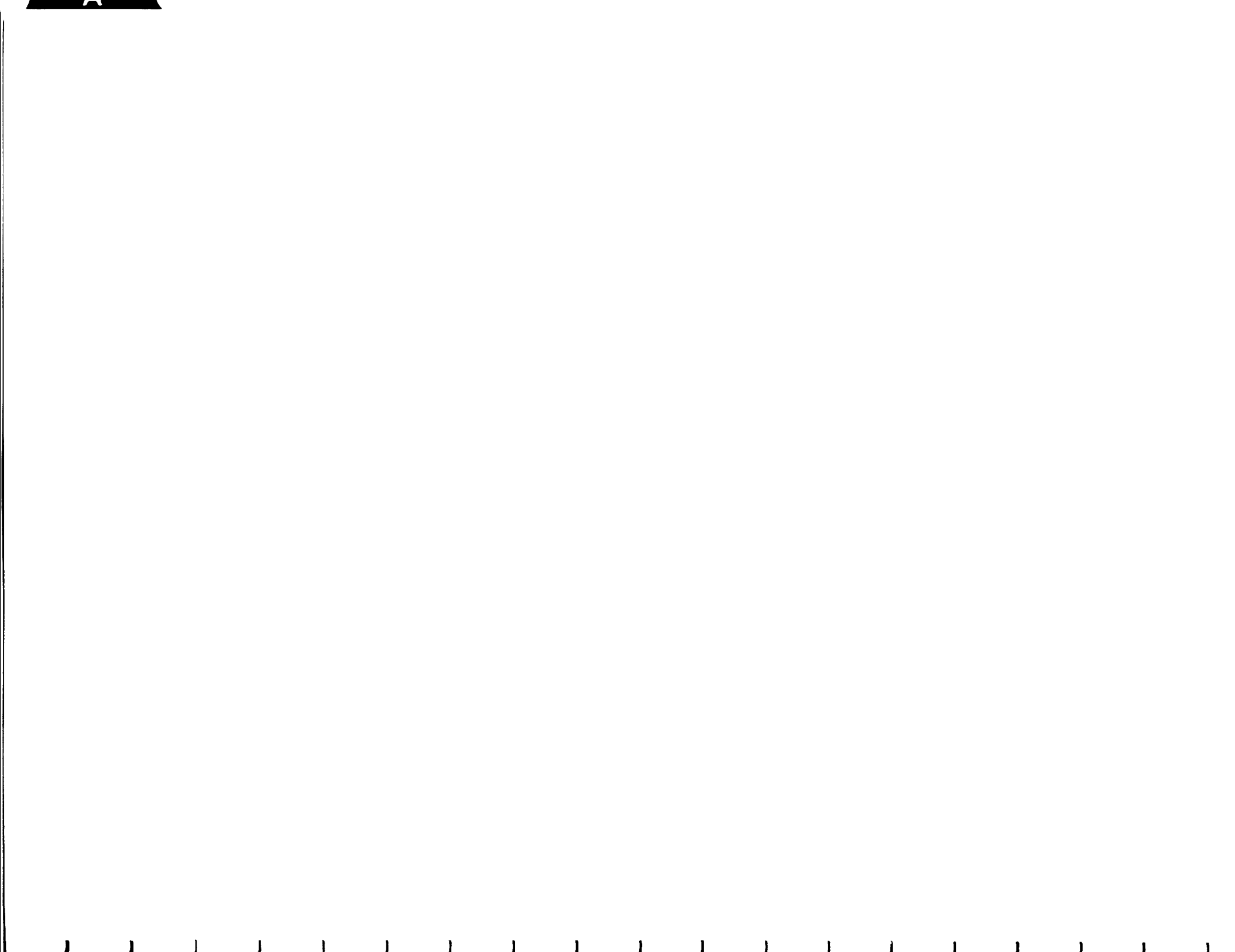

APPENDIX A

DESIGN CALCULATIONS AND SPECIFICATIONS

GROUNDATER EXTRACTION SYSTEM, OFF-SITE DITCHES AND SITE COVER

DESIGN CALCULATIONS

- GROUNDWATER EXTRACTION SYSTEM
- SITE COVER

Summit National Superfund Site
Deerfield Township of Portage County, Ohio

MAY 1993

REF. NO. 2372 (43)

CONESTOGA-ROVERS & ASSOCIATES

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TABLE OF CONTENTS

LIST OF ATTACHMENTS

1.0 GROUNDWATER EXTRACTION SYSTEM

1.1 BURIED CONDUIT STRUCTURAL DESIGN (PIPE AND: MEDIA DRAIN)

Given:

- maximum burial depth 30 ft
- average soil density 114 p.c.f. ≈ 3078 lbs/yd^3
- allowable pipe deflection 5%
- pipe dia. 6" HDPE

Modified Iowa Equation (Dr. Spangler, 1955):

$$\Delta X = \frac{D1\ K\ Wc\ r^3}{E1 + 0.061\ E' r^3}$$

ΔX = deflection inches

D1 = 2.0 (deflection lag factor, Greenwood 1975)

K = 0.110 (bedding constant, Greenwood 1975)

$EI = 0.136\ r^3 \frac{F}{\Delta X}$

$\frac{F}{\Delta X}$ = 60.0 psi (pipe stiffness value by pipe manufacturer)

r = radius of pipe = 3 in.

EI = 0.136 x 27 x 60 = 220.3 psi

E' = 2000 psi (soil stiffness factor for crushed stone @ compaction ≥ 70% relative density)

Wc = loading per unit length (lb/L in)

Wc = P x 2r

P = soil pressure (psi)

$P = \omega \times h$

ω = 114 p.c.f. soil density

h = 30 ft max. depth

$P = 114 \times 30 = 3420$ psf = 23.8 psi

$Wc = 23.8 \times 6 \approx 142.8$ lb/L in

$$\Delta X = \frac{2.0 \times 0.110 \times 142.8 \times 27}{220.3 + 0.061 \times 2000 \times 27} = \frac{848.2}{3514.3} = 0.24 \text{ in}$$

$$\%\Delta X = \frac{0.24}{6.0} = 4\% < \%\Delta X = 5\%$$

Therefore, corrugated HDPE pipe is acceptable at burial depth of up to 30 feet.

According to manufacturer's (ADS Inc.) recommendation, drainage pipe to be used shall be HDPE, corrugated, perforated, smooth interior, landfill grade type, with minimum pipe stiffness of 86 lbs/in/in.

1.2 EXTRACTION WELL, WET WELL AND FORCEMAIN SYSTEM DESIGN

1.2.1 Extraction Well Design

Given:

- Depth to water level including drawdown = 80 ft.
- difference in elevation = 4 ft. (worst case)
- forcemain, horizontal longest run = 100 ft.

- minimum HDPE forcemain size 2"Ø
- maximum expected flow rate = 5 gpm

Total dynamic head required:

- vertical lift	80.0 ft.
- difference in elevation	4.0 ft.
- friction losses (5 GPM @ 2"Ø @ 100 ft)	0.2 ft.
- friction losses (5 GPM @ 1"Ø @ 80 ft)	1.54 ft.
- minor losses (flow meter, flow control valve, fittings)	15.0 ft.
TOTAL TDH	100.8 ft.

Pump Selection:

Submersible electrical pump Grundfos; Model 5E8 flow range 1.2-7 GPM; 1/3 HP, max TDH of 200-210 ft.; pump outlet 1" dia. equipped with built-in check valve. 3-wire Franklin electrical motor, single phase, 230 volts.

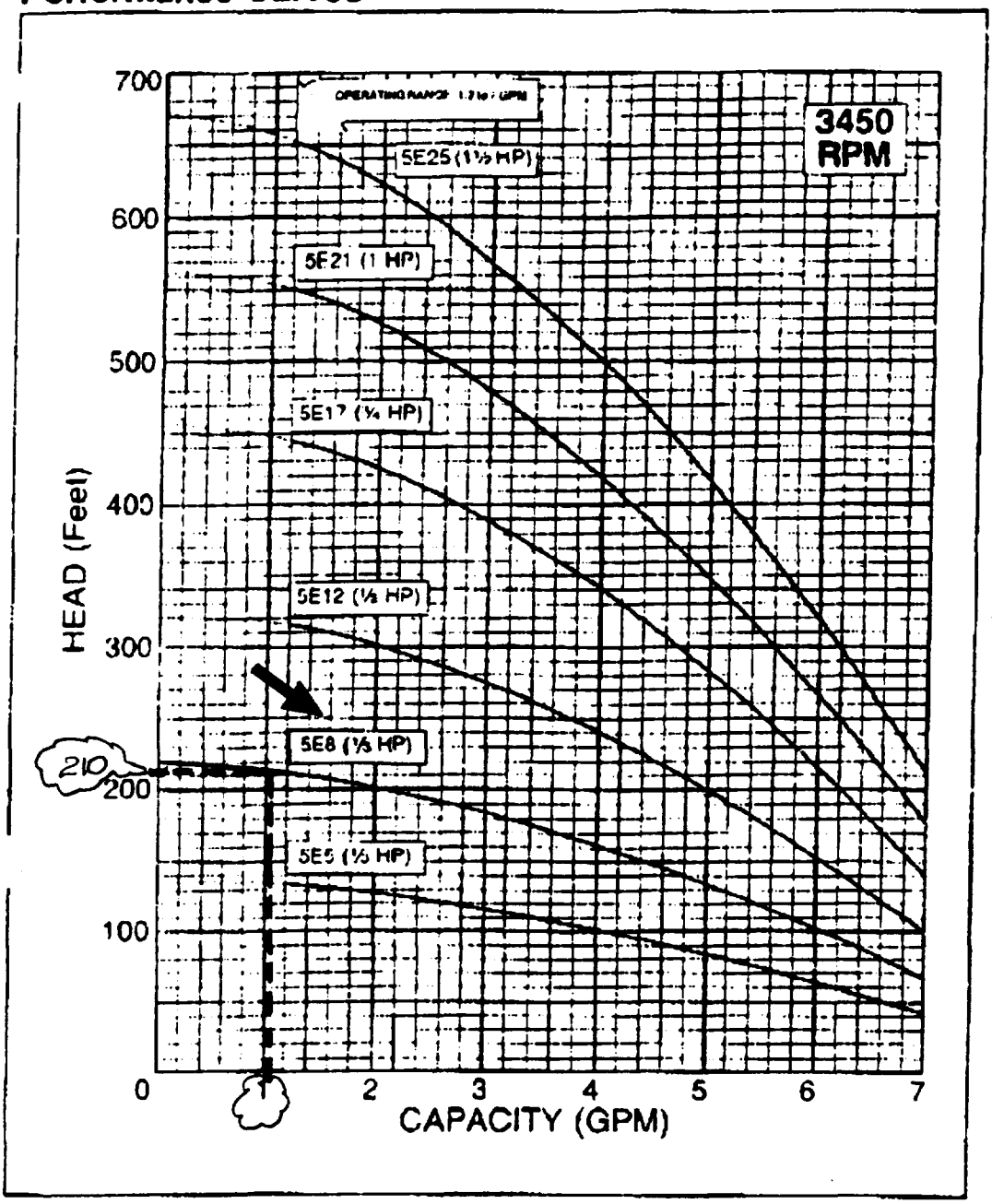
Forcemain Size:

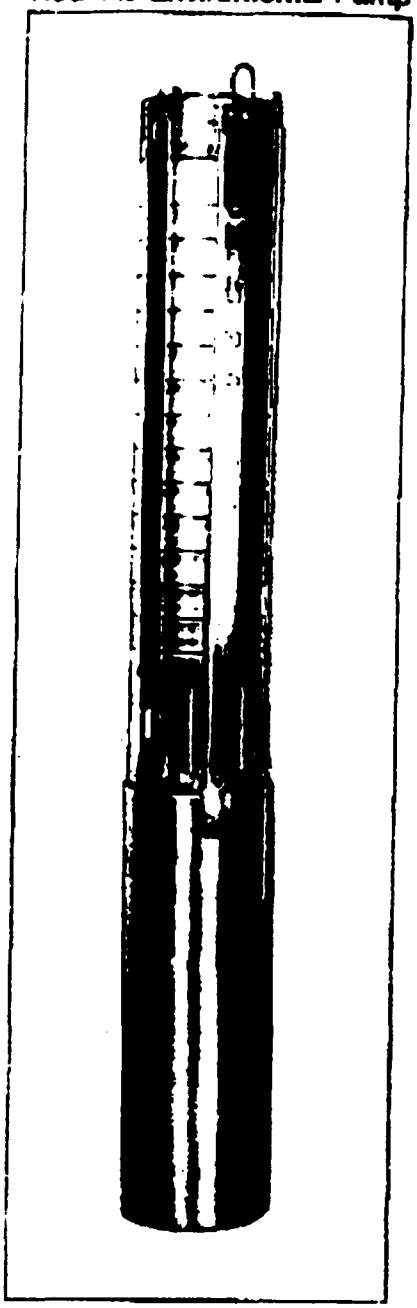
Proposed forcemain size 2"Ø will result in minimal friction losses of approximately 0.5 ft.

Proposed Mechanical Components:

1) Pitless adaptor Maass Model J, drop pipe size 1"Ø.

Performance Curves





Materials of Construction

REDI-FLO PUMP END	
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	304 Stainless Steel & Teflon®
Diffuser Chamber	304 Stainless Steel
Impeller Seal Ring	Teflon®
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	304 Stainless Steel
Coupling	329/420/431 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
ermodiate Bearings	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR	
Nema Top	304 Stainless Steel
Studs & Fasteners	304 Stainless Steel
Nuts	316 Stainless Steel
Sand Slinger	Viton®
Shaft Extension	431 Stainless Steel
Diaphragm	Viton®
Stator Housing	304 Stainless Steel
Fill Plug Screw	304 Stainless Steel
Fill Plug Washer	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR LEADS	
Connector Sleeve	304 Stainless Steel
Connector Potting	Scotch Guard #3® Epoxy w/Viton® Cap
Connector Plug	Viton®
Lead Insulation	Teflon®

NOTE: Specifications are subject to change without notice.

RF-TL-005 7/1/90
PRINTED IN U.S.A.

2) Flow meter, Badger Model OP, 1/2"Ø, bronze body, kynar piston, range 1-6 gpm, equipped with Model PFT-420 Flow Transmitter and remote readings Model ER-7R, single indicator for flow rate to be installed @ well and for totalization in treatment plant.

3) Gate valve, 1"Ø Crane No. 438 or Watts WGV.

4) Flow control valve, Series 44, 1/2"Ø ball valve equipped with HQ99 Set Point Controller and electric actuator, Worcester Co.

5) Liquid level electrodes

Grundfos Pumps

Ohio distributors: Central Pumps - distributor of standard product
S-models
(513)-890-1206
Dayton, Ohio - Mark

1.2.2 Wet Well Design

Given:

- depth to tile system = 28 ft
- sump depth = 6 ft
- forcemain length, approx. 880 ft
- forcemain size 3"Ø

- maximum expected flow 50 GPM (including six extraction wells flow of 6 GPM)
- difference in elevation = 4 ft

Total dynamic head required:

- vertical lift 28 + 6	34 ft
- difference in elevation	4 ft
- friction losses @ 50 GPM in 3"Ø @ 900 ft, (Worst case, 2 pumps @ 2 x 50 GPM = 100 GPM in 3"ø, assume 50% friction losses for single pump)	11 ft
- minor losses (flow meter, valves and fittings)	15 ft
- treatment plant reach	15 ft
TOTAL TDH	79.0 ft.

Pump Selection:

Submersible electrical pump Grundfos Model 60S20-4, flow range 40-75 GPM 2HP, max TDH 110 ft @ 50 GPM. Pump outlet 2"Ø equipped with built-in check valve, 3 phase, 460 V electrical motor.

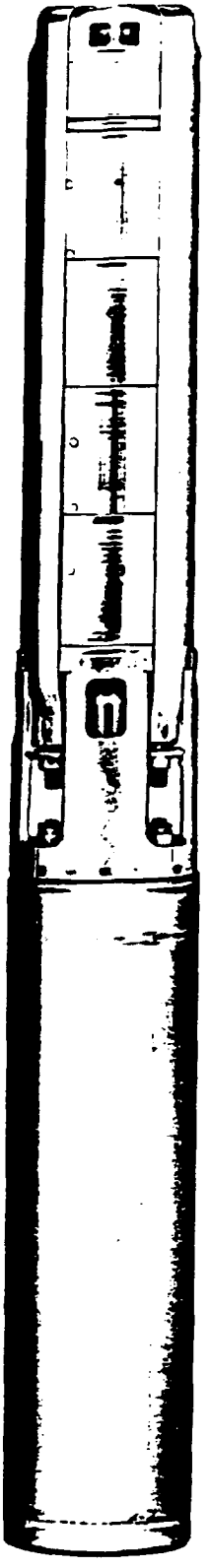
Forcemain size:

Proposed 3"Ø will result in friction losses of 22 ft in worst case (100 GPM initial flow rate).

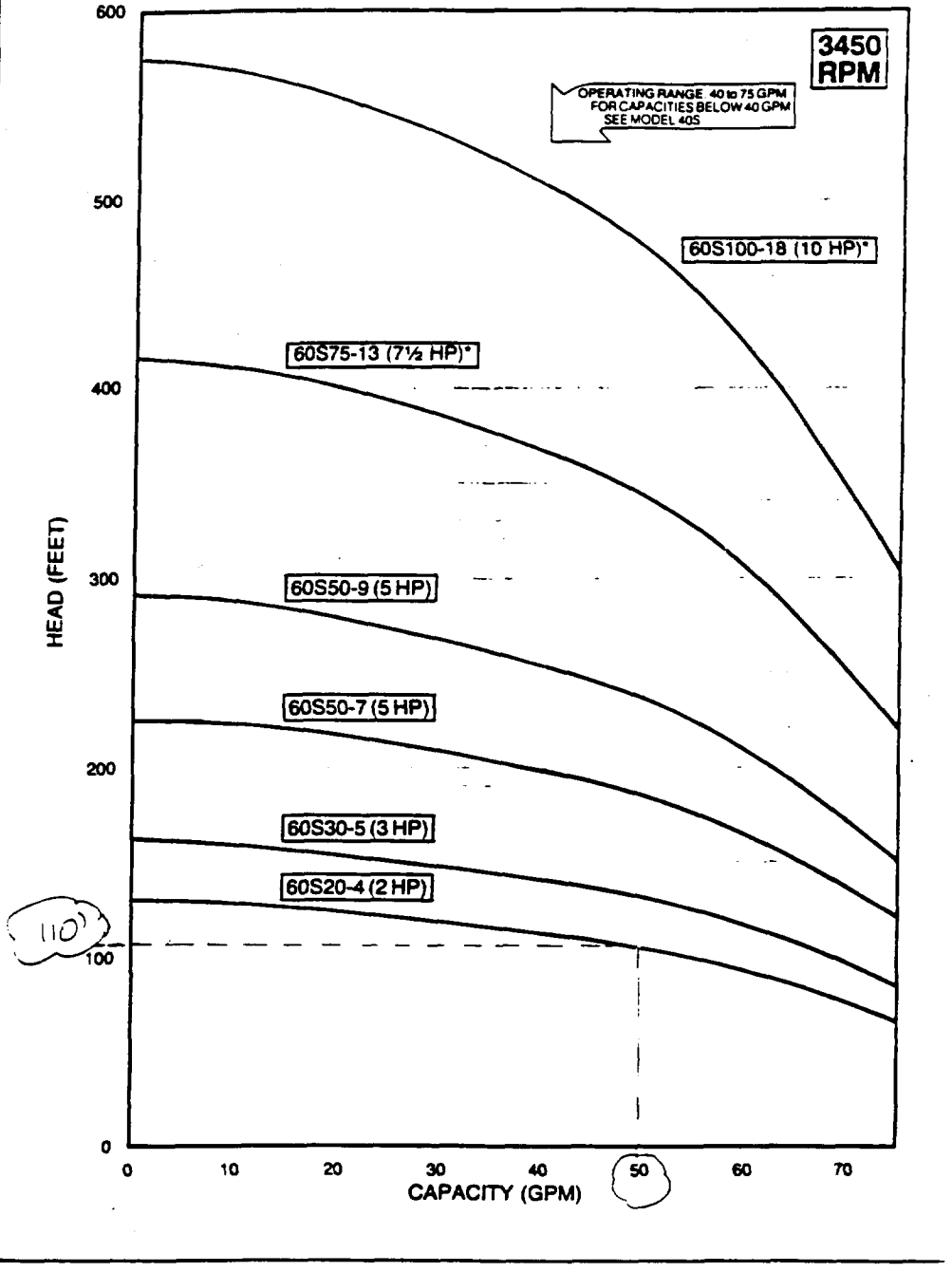
MODEL 60S — 60 GPM — GRUNDFOS

FLOW RANGE
40 to 75 GPM

PUMP OUTLET
2" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
60S20-4	2	31 1/4	3 15/16	39
60S30-5	3	40 3/4	3 15/16	64
60S50-7	5	48 5/8	3 15/16	75
60S50-9	5	53 3/4	3 15/16	80
60S75-13	7 1/2*	70	3 15/16	105
60S100-18	10*	97 1/4	3 15/16	160

Specifications are subject to change without notice.

* A 4-inch motor is provided as standard on these models.

Proposed mechanical components:

1) Pitless adaptor Maass Model J, drop size pipe 2"Ø.

2) Flow meter, Badger Model OP 2"Ø, bronze body, Kynar piston, range 20-100 GPM equipped with Model PFT-420 flow transmitter and remote reading model ER-7R single indicators for flow rate. To be installed @ wet well and for totalization in treatment plant.

3) Gate - valve 2"Ø, Watts Model WGW or Crane No. 438.

4) Flow control valve, Series 44, 2"Ø ball valve equipped with HQ99 Set Point Controller and electric actuator, Worcester Co.

5) Liquid level controls.

1.3 GRADATION REQUIREMENTS FOR PIPE AND MEDIA DRAIN BACKFILL

Data given and requirements

- pipe backfill material, Aggregate No.89 (ASTM-D448, Ohio DOT 703.01) with approximate hydraulic conductivity of 1 x 10 to 1 x 10^{-1} centimeters per second (cm/s).

- native soil gradation analyses results:

d_{85} of soil falls between 15 and 22 mm in general

d_{15} of soil falls between 0.003 and 0.0065 in general.

Applicable filter criteria:

$$\frac{D_{15}\text{ (filter)}}{d_{85}\text{ (soil)}} < 4 \text{ to } 5 > \frac{D_{15}\text{ (filter)}}{d_{15}\text{ (soil)}}$$

↓ ↓

to prevent piping — for sufficient permeability

Use filter material: coarse aggregate size No. 89 Ohio D.O.T. (703-1), D_{15} = 1.2 to 2.8 mm.

Permeability, based on Hazen's Formula is

$K = (D_{10})^2$ where k [cm/s], D_{10} [mm]

D_{10} = 1.0 mm to 2.0 mm

$\therefore$ K = 1 to 4 cm/s, which is greater than value in Design Criteria Document

$\therefore$ okay.

check for soil analyses - lower results, d_{15} = 0.003 mm and d_{85} = 15 mm

$$\frac{2.8}{15} < 4 \text{ to } 5 < \frac{1.2}{0.003}$$ Worst case.

$0.186 < 4 \text{ to } 5 < 400.0$ permeability and filter criteria satisfied

check for soil analyses - higher results,

d_{15} = 0.0065 mm and d_{85} = 22 mm

$\frac{2.8}{22.0} < 4 \text{ to } 5 < \frac{1.2}{0.0065}$ Worse case.

$0.127 < 4 \text{ to } 5 < 184$ permeability and filter criteria satisfied

Criterion for geotextile (soil/filter layer materials surrounding the fabric must have gradations that are compatible with the size of fabric holes (EOS = #50 U.S. STD sieve = 0.297 mm):

$$\frac{d85 \text{ (soil/filter)}}{EOS} > 1 \text{ or } 2$$

d_{85} = 15mm for surrounding soil

$$\frac{15}{0.297} = 50.5 > 1 \text{ or } 2$$

D_{85} = 9 mm for filter material (backfill)

$$\frac{9}{0.297} = 30.3 > 1 \text{ or } 2$$

Conclusion:

1) Criteria for filter (backfill material) and for geotextile are satisfied.

2) Use backfill for pipe and media drain, coarse aggregate, size number 89, according to Ohio D.O.T. 703.01:

Screen Sieve	% Passing by Weight
1/2	100
3/8	90 - 100
No. 4	20 - 55
No. 8	5 - 30
No. 16	0 - 10
No. 50	0 - 5

3. Proposed geotextile for pipe bedding material EOS no smaller than US Sieve #50.

1.4 MECHANICAL COMPONENTS

The specifications for the mechanical components of the groundwater extraction system are included in Attachment 1.

OHIO D.O.T.

TABLE 703-1
SIZES OF COARSE AGGREGATE
(AASHTO M 43)

Size number	Nominal size square openings (1)	Amounts finer than each laboratory sieve (square openings), percentage by weight														
		4	3-1/2	3	2-1/2	2	1-1/2	1	3/4	1/2	3/8	No. 4	No. 8	No. 16	No. 50	No. 100
1	3-1/2 to 1-1/2	100	90 to 100		25 to 60		0 to 15		0 to 5							
2	2-1/2 to 1-1/2			100	90 to 100	35 to 70	0 to 15		0 to 5							
24	2-1/2 to 3/4			100	90 to 100		25 to 60		0 to 10	0 to 5						
3	2 to 1					100	90 to 100	35 to 70	0 to 15		0 to 5					
357	2 to No. 4					100	95 to 100		35 to 70		10 to 30		0 to 5			
4	1-1/2 to 3/4						100	90 to 100	20 to 55	0 to 15		0 to 5				
467	1-1/2 to No. 4						100	95 to 100		35 to 70		10 to 30	0 to 5			
5	1 to 1/2							100	90 to 100	20 to 55	0 to 10	0 to 5				
56	1 to 3/8							100	90 to 100	40 to 75	15 to 35	0 to 15	0 to 5			
57	1 to No. 4							100	95 to 100		25 to 60		0 to 10	0 to 5		
6	3/4 to 3/8								100	90 to 100	20 to 55	0 to 15	0 to 5			
67	3/4 to No. 4								100	90 to 100		20 to 55	0 to 10	0 to 5		
68	3/4 to No. 8								100	90 to 100		30 to 65	5 to 25	0 to 10	0 to 5	
7	1/2 to No. 4									100	90 to 100	40 to 70	0 to 15	0 to 5		
78	1/2 to No. 8									100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5	
8	3/8 to No. 8										100	85 to 100	10 to 30	0 to 10	0 to 5	
89	3/8 to No. 16										100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5
9	No. 4 to No. 16											100	85 to 100	10 to 40	0 to 10	0 to 5
10	No. 4 to 0 (2)											100	85 to 100			10 to 30

(1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.

(2) Screenings.

Where standard sizes of coarse aggregate designated by two or three digit numbers are specified, the specified gradation may be obtained by combining the appropriate single digit standard size aggregates by a suitable proportioning device which has a separate compartment for each coarse aggregate combined. The blending shall be done as directed by the Laboratory.

2.0 RELOCATION OF DRAINAGE DITCHES

2.1 SOUTH DITCH DESIGN

2.1.1 Peak Discharge Calculations

Data given and assumptions:

- rainfall event 24-hour with a one in 25-year return period: rainfall (inches) 4;
- drainage area: 56 acres
- type of cover: soil cover, good pasture
- hydrologic soil group: Mercer PM, Group C
- curve number: CN = 74, (table 2.2)

Check maximum expected flow based on assumed drainage area of 56 acres, using Curve Number Method.

Using Runoff Curve Number Method (TR-55), (see attached pages), final peak discharge to be handled by south ditch is Q_p = 100.80 cfs.

Based on information from Ohio D.O.T. (see attached) existing culvert under Route 225 has been designed for maximum capacity Q = 60 cfs. Based on existing culvert capacity of 60 cfs and contingency of 20 cfs (contribution from Summit National Site and adjacent area south of Site), final capacity of 80 cfs has been assumed as design base for south ditch.

Worksheet 2: Runoff curve number and runoff

Project SUMMIT NATIONAL SUPERFUND SITE By ____ Date NOV./91

Location DEERFIELD /OHIO Checked ____ Date ____

Circle one: (Present) (Developed) SOUTH DITCH

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
MERCER	GOOD PASTURE	74			56	4144
					Totals =	4144

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{4144}{56} = 74$; Use CN = 74

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency ..... yr	25		
Rainfall, P (24-hour) ..... in	4		
Runoff, Q ..... in (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	1.60		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project SUMMIT NATIONAL SUPERFUND SITE By ____ Date NOV/91

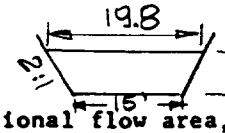
Location DEERFIELD, OHIO Checked ____ Date ____

Circle one: (Present) (Developed) SOUTH DITCH

Circle one: T_c T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

		Segment ID		
Sheet flow (Applicable to T_c only)				
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1) ..				
3. Flow length, L (total L ≤ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		+	=
Shallow concentrated flow		Segment ID		
7. Surface description (paved or unpaved)				
8. Flow length, L	ft			
9. Watercourse slope, s	ft/ft			
10. Average velocity, V (figure 3-1)	ft/s			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=
Channel flow 		Segment ID	SOUTH DITCH	
12. Cross sectional flow area, a	ft^2		20.88	
13. Wetted perimeter, p_w	ft		17.5	
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft		1.19	
15. Channel slope, s	ft/ft		0.0055	
16. Manning's roughness coeff., n			0.025	
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		4.96	
18. Flow length, L	ft		4200	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.24 +	= 0.24
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			

Worksheet 4: Graphical Peak Discharge method

Project SUMMIT NATIONAL SUPERFUNK SITE By ____ Date NOV. '91

Location DEERFIELD / OHIO Checked ____ Date ____

Circle one: (Present) (Developed) SOUTH DITCH

1. Data:

   Drainage area ..... A_m = 0.0875 mi^2 (acres/640)

   Runoff curve number .... CN = 74 (From worksheet 2)

   Time of concentration .. T_c = 0.24 hr (From worksheet 3)

   Rainfall distribution type = II (I, IA, II, III)

   Pond and swamp areas spread throughout watershed ..... = ____ percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4		
4.	Initial abstraction, I_a ..... (Use CN with table 4-1.)	in	0.703		
5.	Compute I_a/P		0.175		
6.	Unit peak discharge, q_u ..... 720 ..... (Use T_c and I_a/P with exhibit 4-II)	csm/in	720		
7.	Runoff, Q ..... (From worksheet 2).	in	1.60		
8.	Pond and swamp adjustment factor, F_p 1.0 (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p ..... (Where $q_p = q_u A_m Q F_p$)	cfs	100.80		

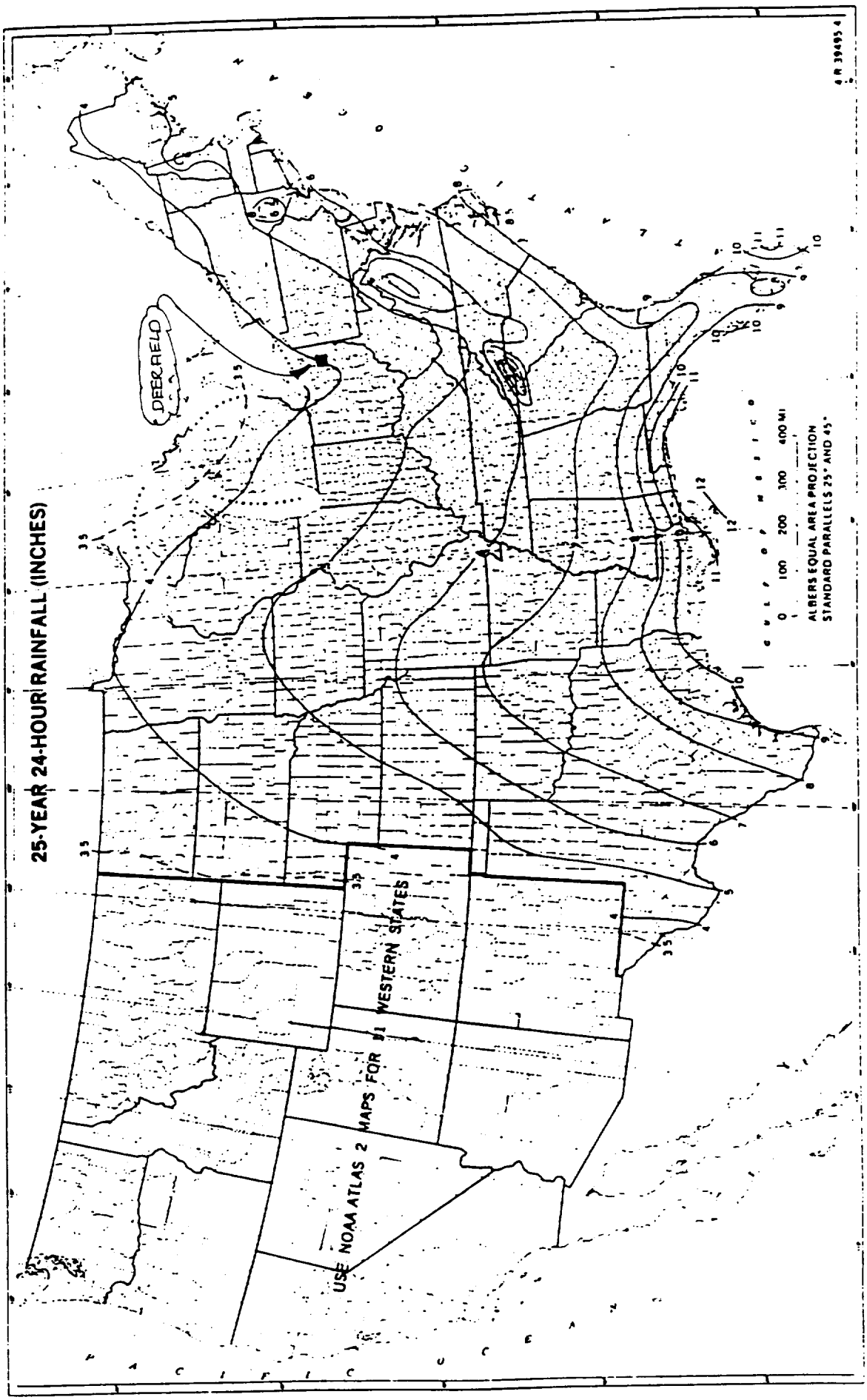
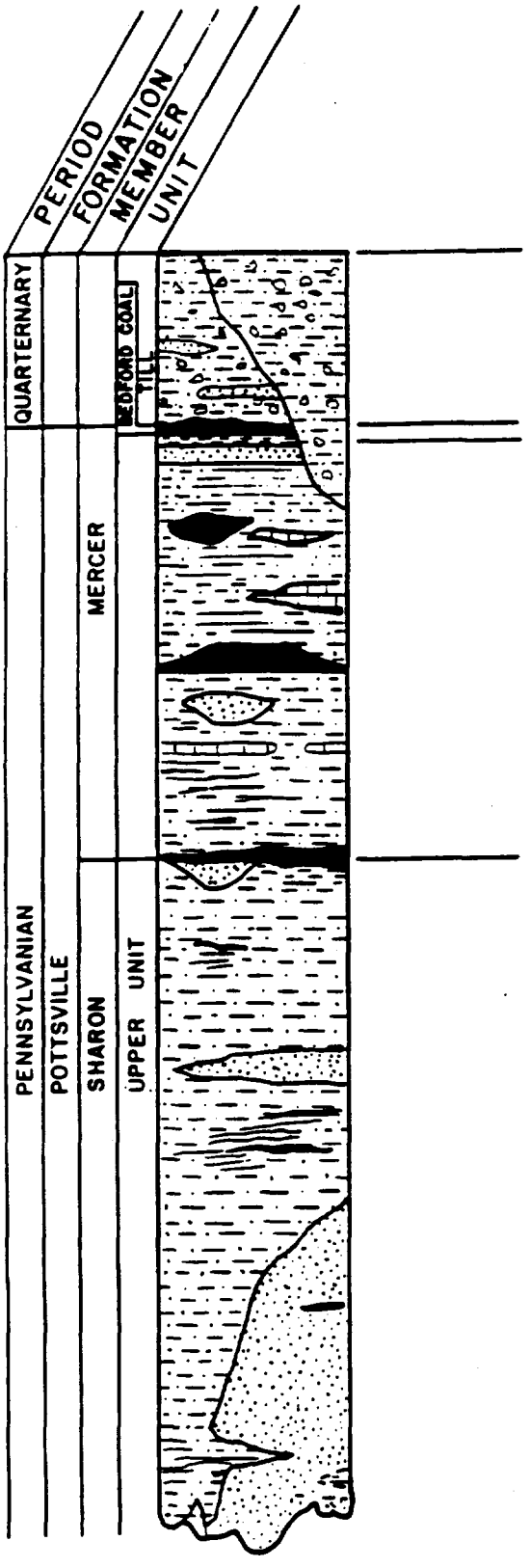


Figure B-6.—Twenty-five-year, 24-hour rainfall.



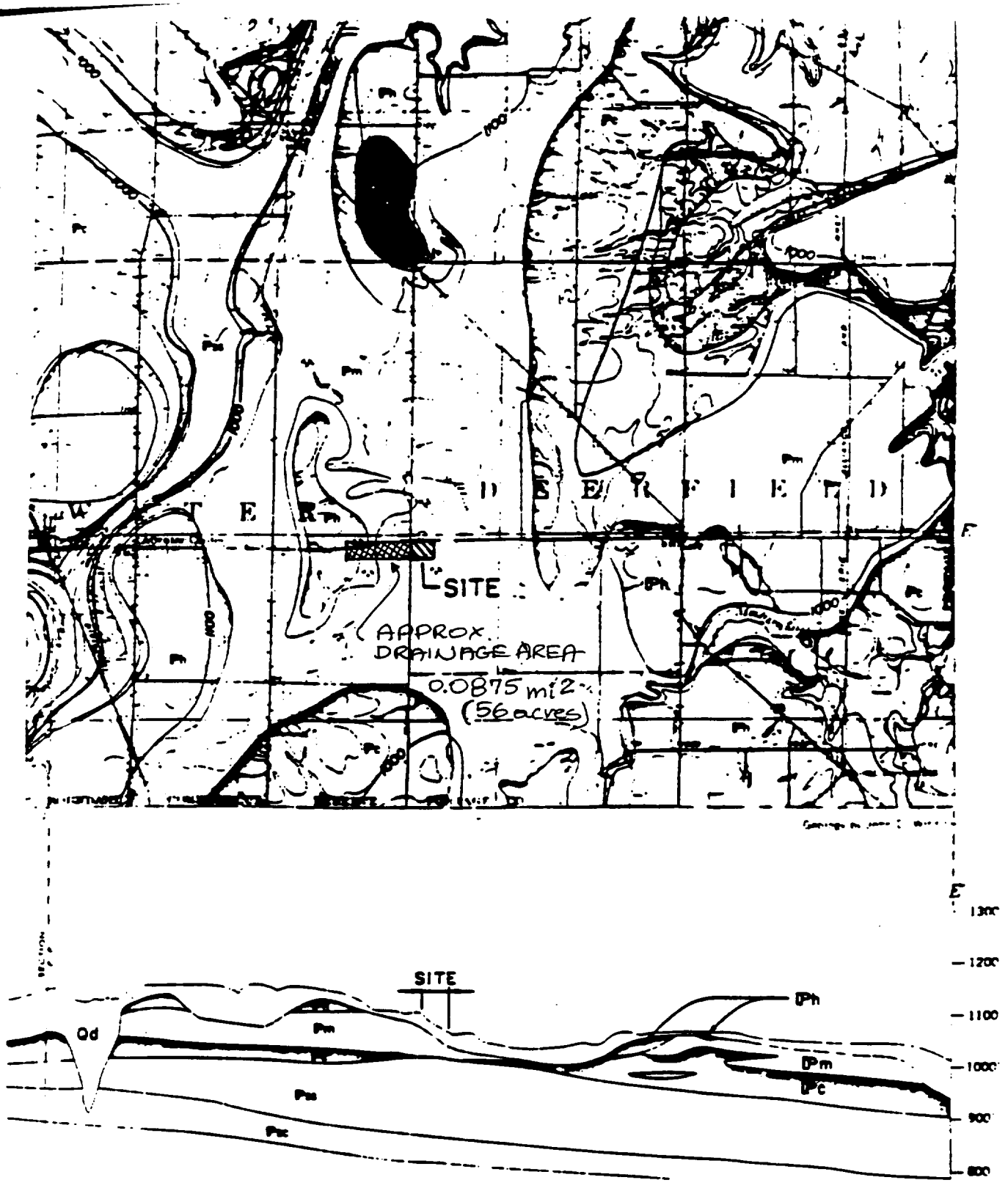
GLACIAL TILL : SILT WITH SAND, GRAVEL AND ROCK FRAGMENTS, OCCASSIONAL SANDY LENSES (0 - 20 FT.)

MINE SPOIL AND FILL (0 - 35 FT.)

MERCER MEMBER : SILTSTONE AND SHALE WITH BEDS OF COAL, CLAYSTONE AND SANDSTONE ; LENSES OF LIMESTONE AND COAL (15 - 35 FT.)

SHARON MEMBER: SILTSTONE WITH LENSES OF SILTY SANDSTONE, COAL AND OCCASSIONAL LIMESTONE, SHALEY IN PLACES (100 + FT)

FIGURE 1-6
GENERALIZED STRATIGRAPHIC COLUMN
SUMMIT NATIONAL FS



LEGEND

Od QUATERNARY, UNDIFFERENTIATED

Ph HOMEWOOD MEMBER

Pm MERCER MEMBER

Pc CONNOQUENESSING SANDSTONE

Pss SHARON MEMBER, SHALE

Psc SHARON MEMBER, CONGLOMERATE

SOURCE: WINSLOW AND WHITE, 1962

FIGURE 1-4
PHYSIOGRAPHIC MAP
SUMMIT NATIONAL RI

texture is given in appendix A for determining the HSG classification for disturbed soils.

Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Hydrologic condition

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-1.—Runoff depth for selected CN's and rainfall amounts[1]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1]Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

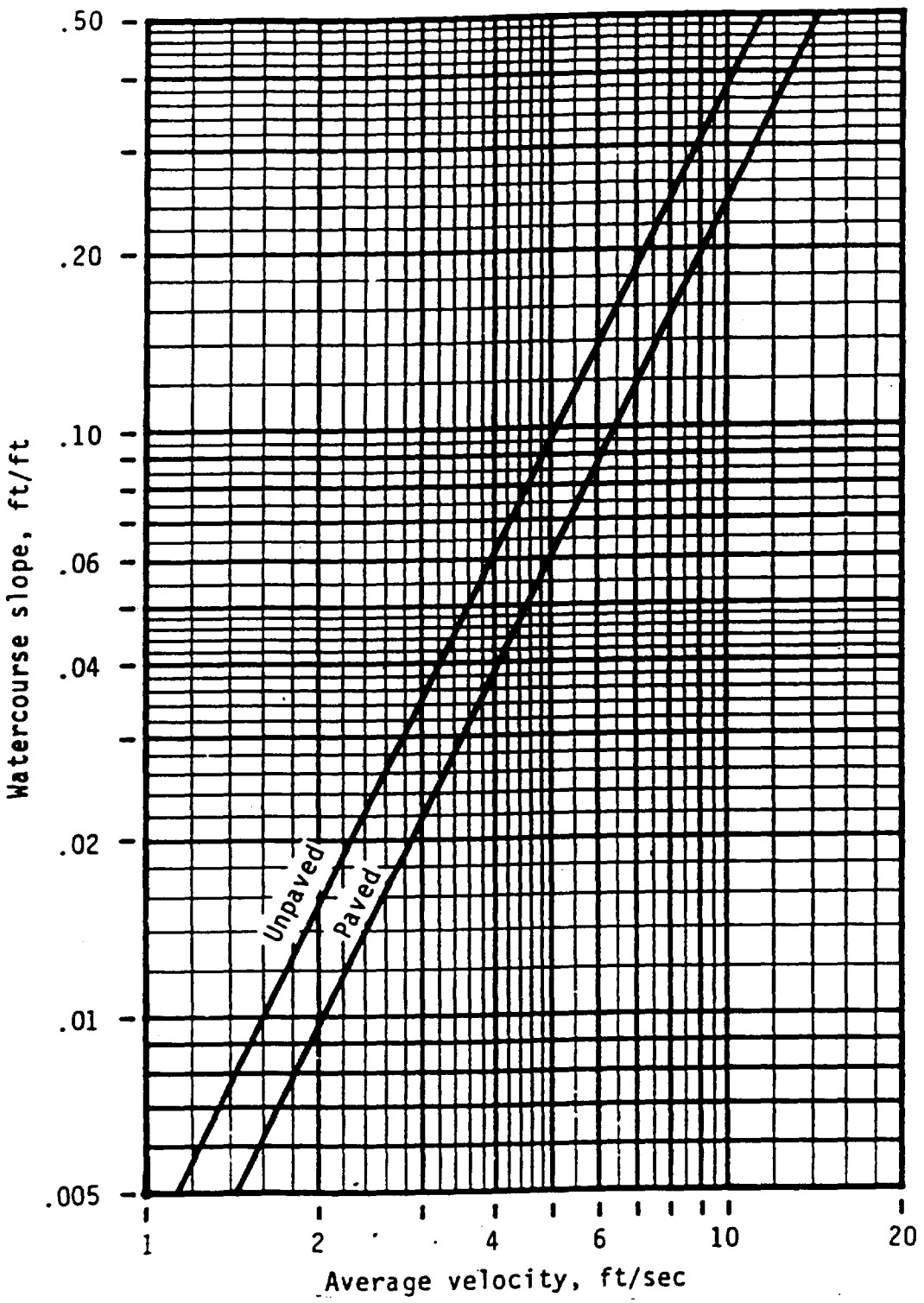


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Chapter 4: Graphical Peak Discharge method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation–Hydrology" (SCS 1983). The peak discharge equation used is

$$q_p = q_u A_m Q F_p \qquad \text{[Eq. 4-1]}$$

where

q_p = peak discharge (cfs);
q_u = unit peak discharge (csm/in);
A_m = drainage area (mi^2);
Q = runoff (in); and
F_p = pond and swamp adjustment factor.

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi^2), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) CN. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (P) is obtained from appendix B or more detailed local precipitation maps. CN and total runoff (Q) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a/P is then computed.

If the computed I_a/P ratio is outside the range shown in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a/P to CN and P.

Peak discharge per square mile per inch of runoff (q_u) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a/P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

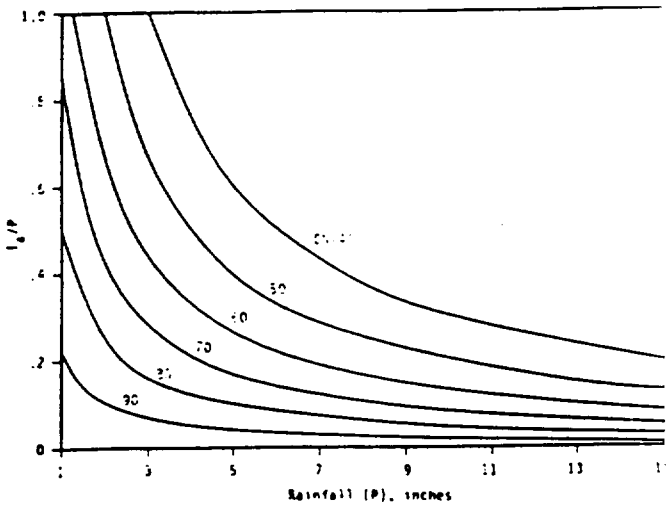


Figure 4-1.—Variation of I_a/P for P and CN.

Table 4-1.—I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

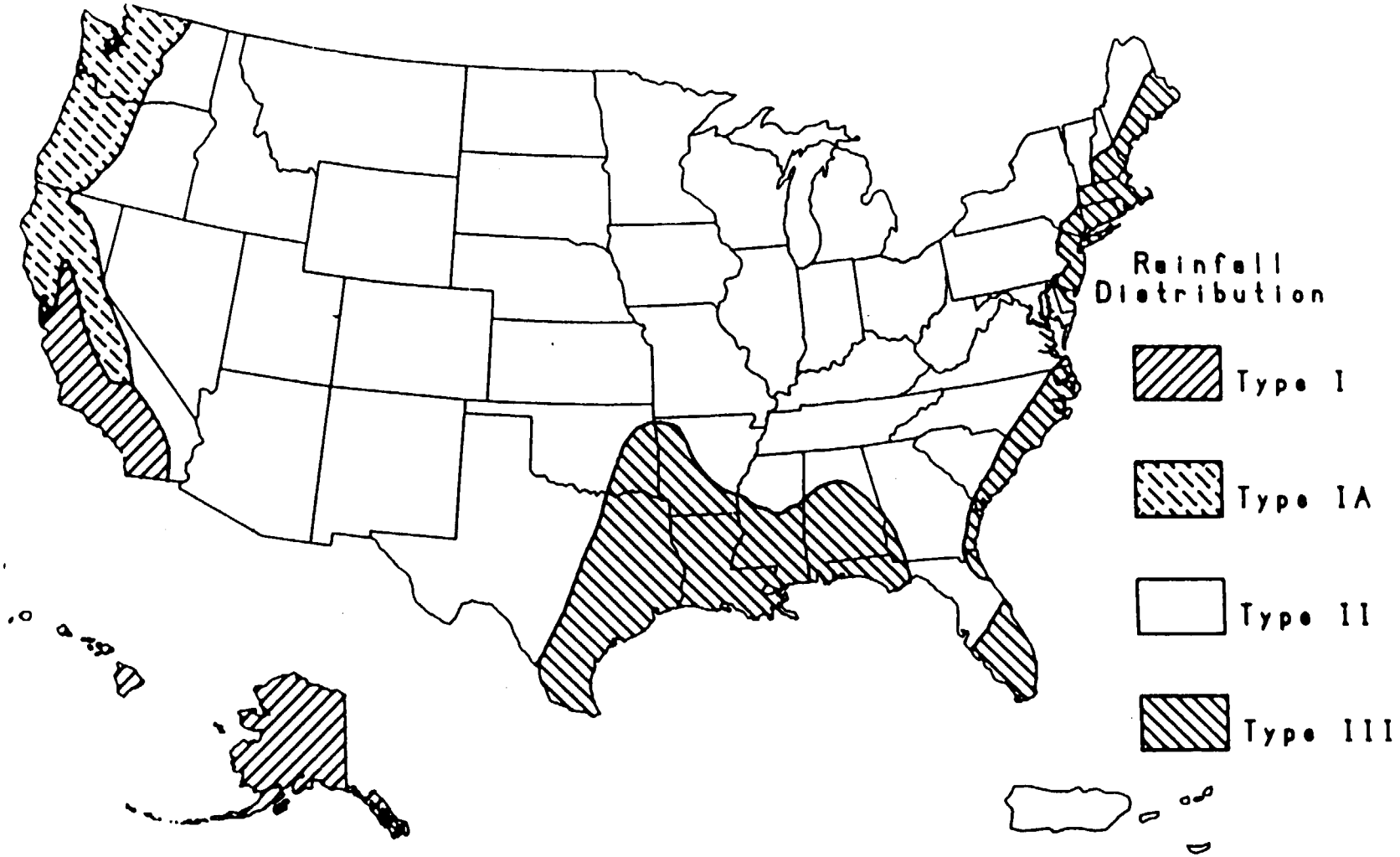
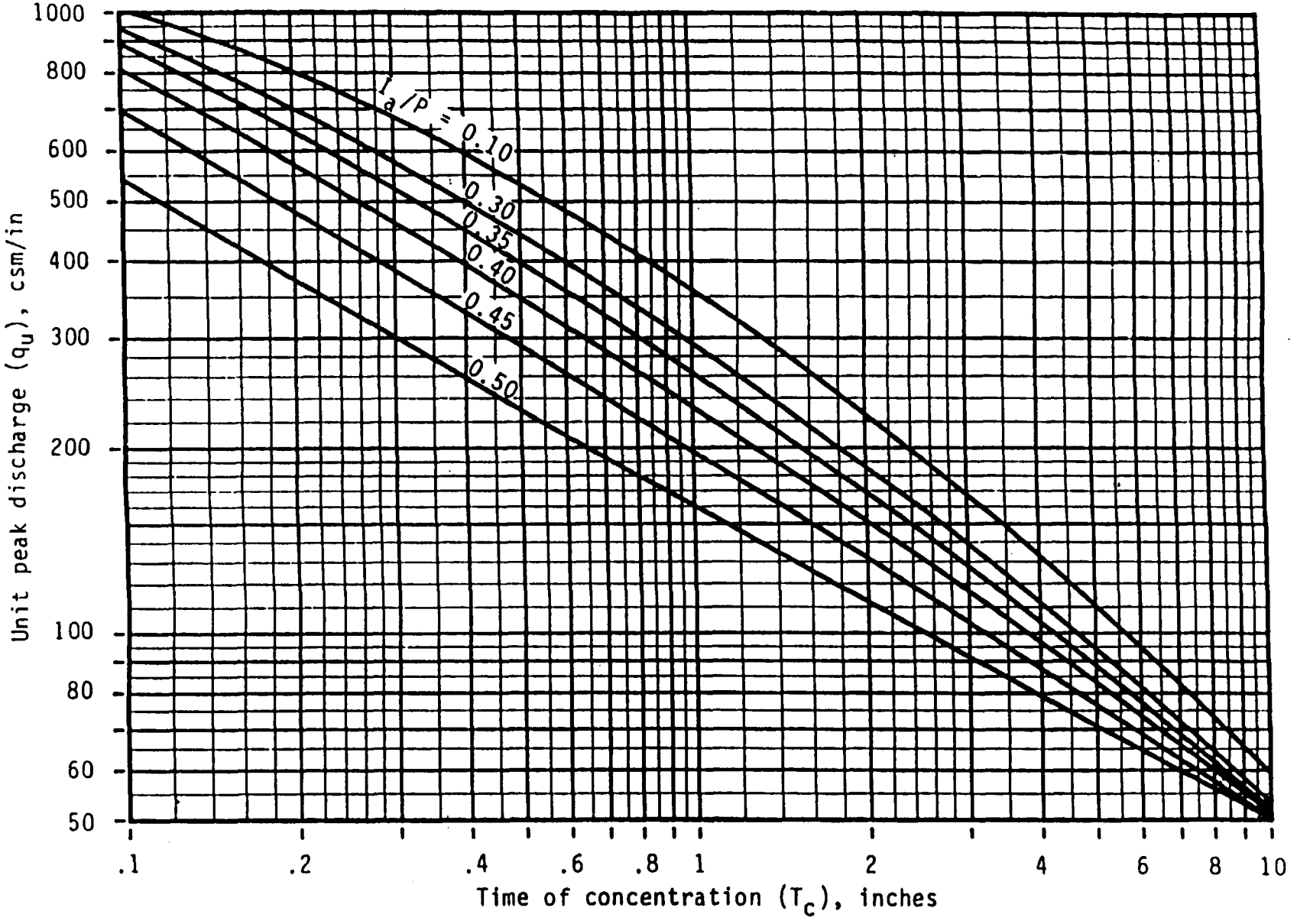


Figure B-2.—Approximate geographic boundaries for SCS rainfall distributions.

Exhibit 4-II: Unit peak discharge (q_u) . SCS type II rainfall distribution



FED. RD. DIVISION	STATE	PROJECT	TYPE FUNDS
2	OHIO		

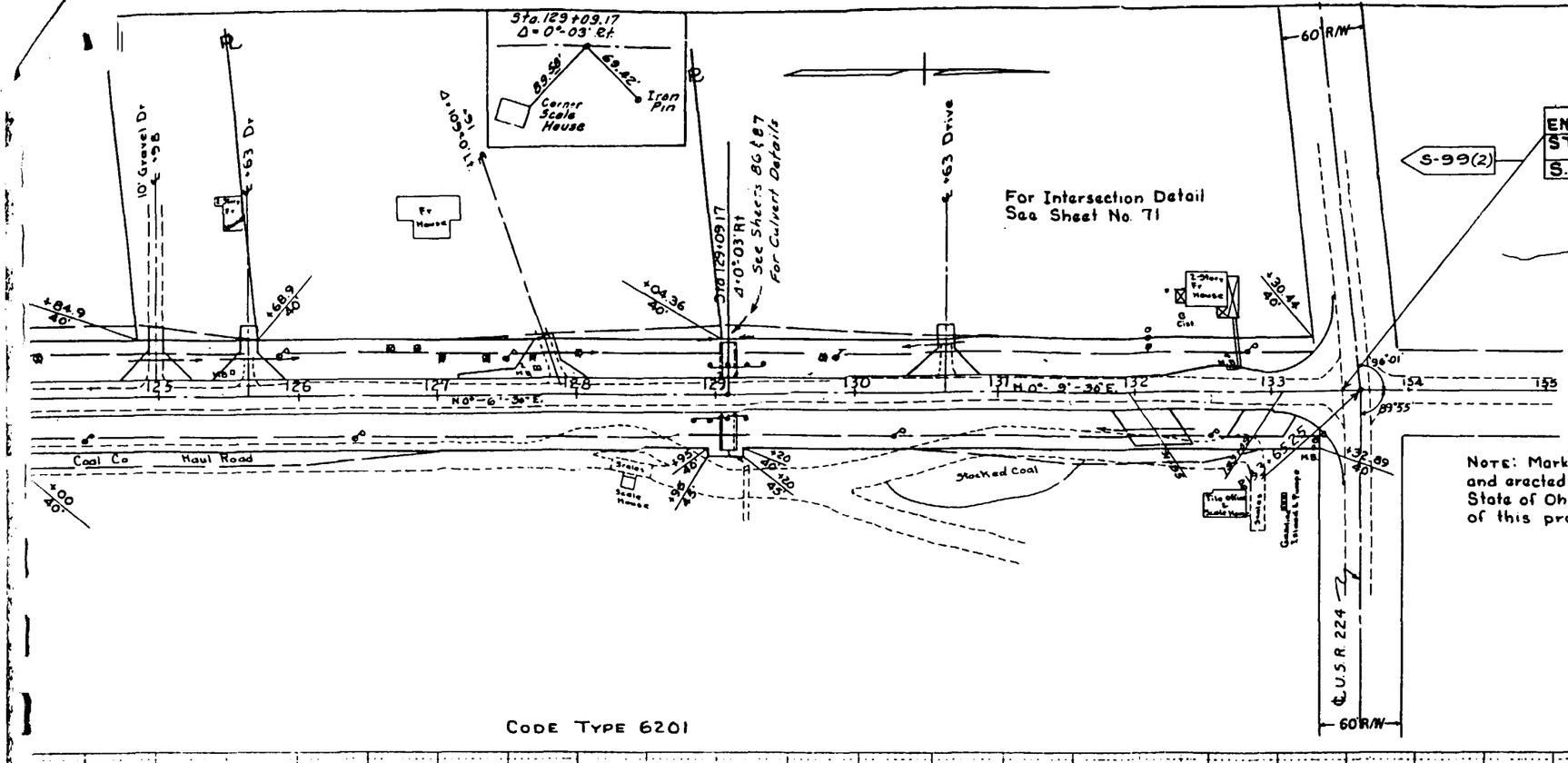
37/101

STA. 225 - 0.38
POR. 225 - 0.00

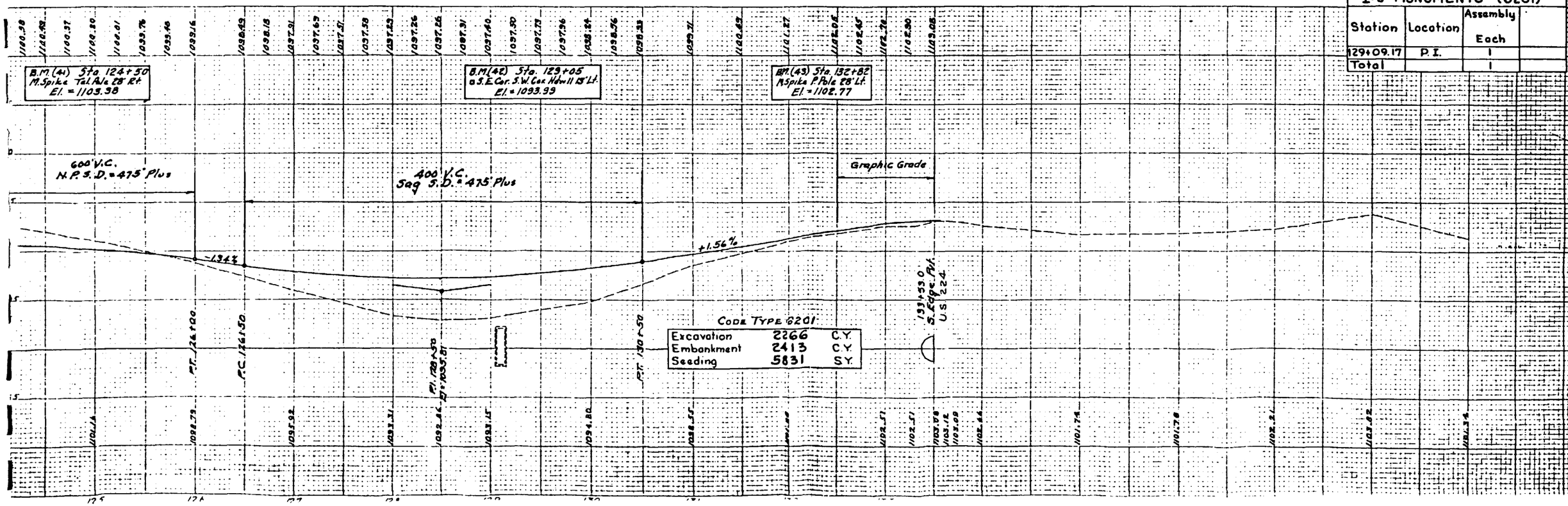
Rec'd CRA
DEC 02 1991
2372-00

END PROJECT & WORK
STA. 133+53.0
S.L.M. 2.53

S-99(2)



Code Type 6201



Code Type 6201

Excavation	2266	C.Y.
Embankment	2413	C.Y.
Seeding	5831	S.Y.

18'
Bit. road mix surface on traffic bound base
EXISTING PAVEMENT ADJOINING END OF PROJECT

NOTE: Marker to be furnished and erected on the left by the State of Ohio before acceptance of this project.

CULVERTS (6201)

Station	See Sheet	Removals Type	Removals Size	Removals Length	New Work Type	New Work Size	New Work Length
129+09.17	86&87				Conc.Box	8'x4'	49'-6"

APPROACHES (6201)

Station	Side ℄	See Sheet	I-22 5" Subbase Cu.Yds.	B-119 6" Base Cu.Yds.	T-90 Prime Gals	B-35 2½" Base Cu.Yds.	B-85 1½" Base Cu.Yds.	T-95 1½" Surface Cu.Yds.	T-95 1" Surface Cu.Yds.	New 12" Pvt Rec App Lin Ft
124+98	Lt			15.9					5.4	40
125+69	Lt			18.9					5.4	40
127+34	Lt			18.0					6.1	44
130+69	Lt			15.9					5.4	32
131+95	Rt	71	18.4	21.9	42	9.5	4.1	4.9		70
133+09	Rt	71	14.0	16.1	32	7.2	3.1	3.7		
132+67	Lt			5.0					1.8	
133+53	Rt&L	71	19.0	29.1	48	10.7	4.6	5.6		
Totals			51.4	131.2	122	27.9	11.8	14.2	29.1	226

383

I-15.13 GUARD RAIL (6201)

Station From	Station To	Side ℄	Lin Ft. New
128+84	129+71.5	Rt	37.5
128+97	129+34.5	Lt	37.5
Total			75

REMOVALS (6201)

Station From	Station To	Side ℄	Trees 12"-18"
124+98	133+53	Rt&L	6
Totals			6

I-8 MONUMENTS (6201)

Station	Location	Assembly Each
129+09.17	P.I.	1
Total		1

FED. AID DIVISION	STATE	PROJECT	
2	OHIO		

86/101

STARK-225-0.38
PORTAGE-225-0.00

Rec'd CRA
DEC 02 1991
2372-01

Fill old channel with channel excavation

New Channel

22½°

45°

77'-6"
28'-0"
25'-6"
17'-0"
13'-2⅜"
14'-3⅝"
15'-6"
24'-0"
8'-6"
8'-6"
8'-0"
30°19'
8"
STA 129+09
Remove Wing Wall
Remove Wing Wall
Remove Wing Wall
Remove Wing Wall
36" V.S.P.

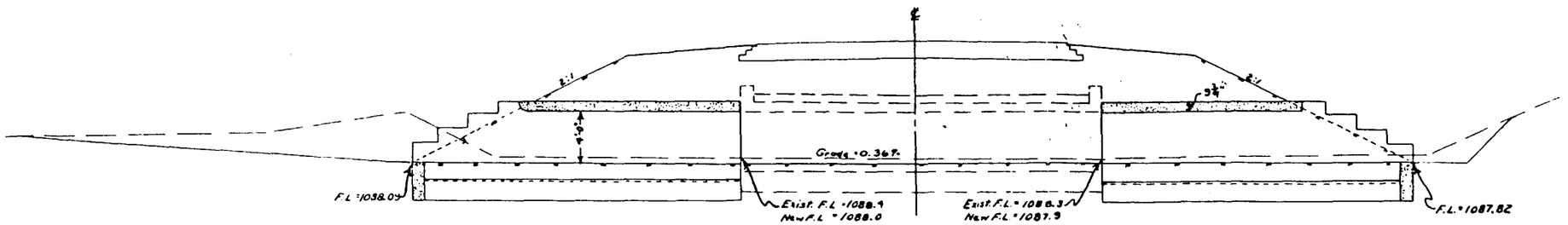
0+47.35 | 0+68 | 0+86.85 | 1+00 | 1+14.8 | 1+30 | 1+43 | 1+56.5

PART PLAN
Scale: 1"=5'-0"

1+96.5 = 0 Section
1091.5
1087.82
1+43
1090.0
1087.82
1+90
1088.5
1087.3
1+14.8
1088.3
1088.0
0+86.85
1088.4
1088.07
0+68
1088.5
1088.1
0+41.35
1092.0
1088.85
0+15
1090.2
0+20 = 0 Section
1090.00

CHANNEL EXCAVATION
Scale: 1"=10'-0"

EA.	C.Y.
0	1.2
19	1.3
6	4.1
3	3.1
3	3.1
6	8.0
56	20.7
14	6.5
0	
Total	48.0 C.Y.



CROSS-SECTION
Scale: 1"=5'-0"

1097.48
STA. 129+09
1093.29

STRUCTURE DATA

Type: SLAB TOP CULVERT EXTENSION
Size: 8'-0"X4'-0"X25'-6"LT.& 8'-0"X4'-0"X24'-0"RT.
Work Required: Remove existing four wing walls. Build 8'X4'X25'-6" slab top culvert extension to the left & 8'X4'X24'-0" slab top culvert extension to the right as per plan. Excavate channel change as per plan. Note that the channel excavation is computed down to the flow line inside culvert also.

For reference drawings see: S.T.C. '47 in Std Brdg C

★ ESTIMATED QUANTITIES Code

E-2: Excavation for Structures	= 49. cu. yds.
E-3: Channel Excavation	= 48. cu. yds.
S-1: Concrete for Structures (Class "E")	= 34.5 cu. yds.
S-4: Reinforcing Steel	= 2599 Lbs.
S-22: Removal of Portions of Existing Structure	= Lump
S-23: Dowel Holes	= 44 Ea.

Drainage Area = 80 acres
Q_{25} = 60 c.f.s.

20

★ Quantities carried to Sheet No. 5

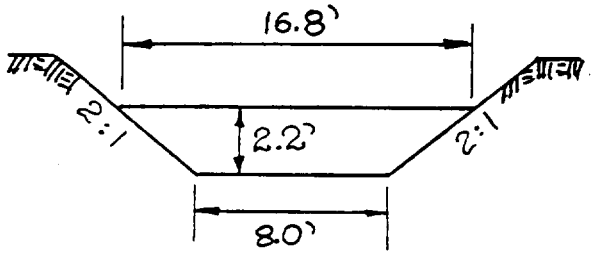
STA. 129+09—PORTAGE
8'-0"X4'-0" SLAB TOP CULVERT
EXTEND 25'-6" LT. & 24'-0" RT.
SHEET 1 OF 2 SHEETS

POR-225-0244

2.1.2 South Ditch Alignment of Cross-Section Design

Given

- peak discharge Q_p = 80.0 cfs (based on Q25 = 60 cfs for Route 225 exist. culvert design +20 cfs contingency);
- upstream invert elevation, approximately 200 feet below head wall Elevation 1087.00;
- downstream invert elevation @ discharge to south impoundment, Elevation 1085.70;
- side slope 2:1;
- ditch slope s = 1:500; 0.002
- Manning coefficient n = 0.025 (earth ditches)
- ditch bottom width b = 8.0 feet



$$A = \frac{16.8 + 8.0}{2} \times 2.2 = 27.28 \text{ ft}^2$$

$$W_p = 16.9 \text{ ft.}$$

$$R = \frac{A}{W_p} = 1.61$$

$$V = \frac{1.49 \times R^{2/3} \times S^{1/2}}{n} = \frac{1.49 \times 1.61^{\frac{2}{3}} \times \sqrt{0.002}}{0.025} = 3.68 \text{ ft/s}$$

check velocity by flow formula:

$$V = \frac{Q}{A} = \frac{80.0}{27.28} = 3.00 \text{ ft/s}$$

Estimated velocities of 3.00 to 3.68 ft/sec, are within range of permissible velocities for vegetated channels. < 5 ft/s.

2.2 EAST DITCH DESIGN

2.2.1 Peak Discharge Calculations

Date given and assumptions:

- rainfall event 24 hour with one in 25 years return period; rainfall inches 4;
- drainage area: 11 acres;
- type of cover: soil cover - good pasture;
- hydrologic soil group: Mercer Pm, Group C
- curve number: CN = 74, (Table 2.2)

Using Runoff Curve Number Method (TR-55) see attached pages, final peak discharge to be handled by east ditch is Q_p = 25.84 cfs.

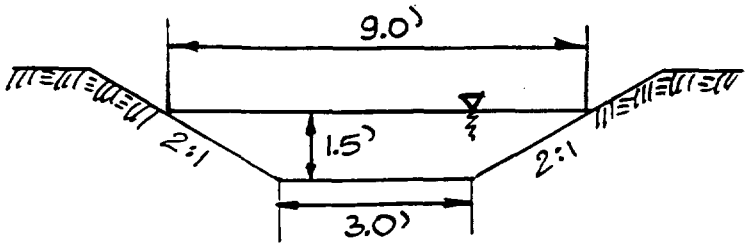
2.2.2 East Ditch Alignment and Cross-Section Design

Given

- peak discharge, Qp = 25.84 cfs;
- upstream invert elevation @ Watson House, Elev. 1084.00;
- downstream invert elevation 1078.00;
- side slope 2:1;

- ditch slope S = 1:500 = 0.002 (min.); (0.02 (max.)
- Manning coefficient n = 0.035 (rip-rap lining)
- ditch bottom width b = 3 ft.

Design for minimum slope S = 0.002



$$R = \frac{A}{Wp} = \frac{(3 + 9.0)\ 0.5 \times 1.5}{3 + 2 \times 3.10} = \frac{9}{9.20} = 0.98$$

$$V = \frac{1.49 \times R^{2/3} \times 5\ 1/2}{12} = \frac{1.49 \times 0.98^{2/3} \times 0.002^{1/2}}{0.035} = 1.88\ ft/s$$

check velocity by flow formula:

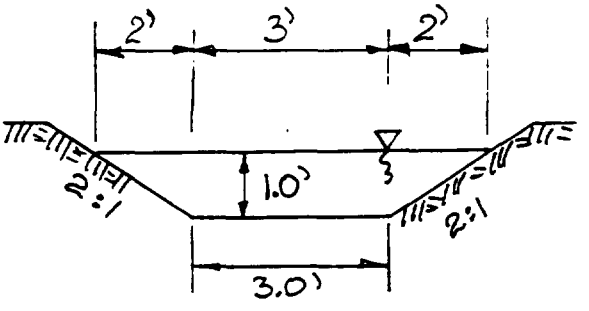
$$V = \frac{Q}{A} = \frac{25.84}{9.0} = 2.87\ ft/s$$

Check velocity for maximum slope S = 0.02

$$R = \frac{A}{Wp} = \frac{(4.0 + 3)\ 0.5 \times 1.0}{3 + 2 \times 2.10} = \frac{5}{7.2} = 0.70$$

$$V = \frac{1.49 \times 0.70^{2/3} \times \sqrt{0.02}}{0.035} = 4.74\ ft/s$$

check velocity by flow formula:



$$V = \frac{Q}{A} = \frac{25.84}{5.0} = 5.17 \text{ ft/s}$$

Estimated velocities of 1.88, 2.87, 4.74 and 5.17 ft/s are within range of permissible velocities for rip rap lining.

Rip rap size: (Highway Research Report No. 108)

$$D_{50} = 12\,(118 \times Q \times S_b^{13/6} R/W_p)^{2/5} =$$

$$12\,(118 \times 25.84 \times 0.02^{13/6} \times 0.70/7.2)^{2/5} = 3.94"$$

Rip rap gradation range: Assume $D_{50} = 4$ in

2.0 x 4 = 8" - 100%
1.6 x 4 = 6" - 85%
1.0 x 4 = 4" - 50%
0.5 x 4 = 2" - 15%

} Percent of total weight smaller than the given size

Rip rap lining thickness shall be of at least two times the D_{50} (filter layer is used).

Rip rap layer thickness = $2 \times D_{50} = 2 \times 4 = 8$ inches

Filter layer - assume/select granular material - coarse aggregate Ohio DOT 703-1, size No. 6:

1" Ø - 100%
3/4" Ø - 90 - 100%
1/2" Ø - 20 - 55%
3/8"Ø - 0 - 15%
No. 4 - 0 - 5%

} % finer by weight

Check filter criteria:

1. $\frac{D15 \text{ rip rap}}{d85 \text{ filter}} < 5 < \frac{D15 \text{ rip rap}}{d85 \text{ filter}} < 40$

$\frac{2"}{3/4"} < 5 < \frac{2"}{3/8"}$ $\quad 2.66 < 5 < 5.33$ O.K.

2. $\frac{D50 \text{ rip rap}}{d50 \text{ filter}} < 40$ $\quad \frac{4"}{1/2"} = 8 < 40$ O.K.

Filter layer thickness = 6 inches.

Proposed geotextile: Filter fabric EOS = No. 70-100 US Standard Sieve.

Worksheet 2: Runoff curve number and runoff

Project SUMMIT NATIONAL SUPERFUND SITE By ____ Date NOV/91

Location DEERFIELD / OHIO Checked ____ Date ____

Circle one: (Present) (Developed) EAST DITCH

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
MERCER	GOOD PASTURE	74			11	814
					Totals =	814

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{814}{11} = 74$; Use CN = 74

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency ..... yr	25		
Rainfall, P (24-hour) ..... in	4		
Runoff, Q ..... in (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)	1.60		

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project SUMMIT NATIONAL SUPERFUND SITE By ____ Date ____

Location DEERFIELD/OHIO Checked ____ Date ____

Circle one: (Present) (Developed) EAST DITCH

Circle one: T_c T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID			
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1) ..				
3. Flow length, L (total L ≤ 300 ft) ..... ft				
4. Two-yr 24-hr rainfall, P_2 ..... in				
5. Land slope, s ..... ft/ft				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t ..... hr		+		=

Shallow concentrated flow	Segment ID			
	EAST DITCH			
7. Surface description (paved or unpaved)	UNPAVED			
8. Flow length, L ..... ft	800			
9. Watercourse slope, s ..... ft/ft	.002			
10. Average velocity, V (figure 3-1) ..... ft/s	2.2			
11. $T_t = \frac{L}{3600\,V}$ Compute T_t ..... hr	0.10	+		= 0.10

Channel flow	Segment ID			
12. Cross sectional flow area, a ..... ft^2				
13. Wetted perimeter, p_w ..... ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ..... ft				
15. Channel slope, s ..... ft/ft				
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{2/3}\,s^{1/2}}{n}$ Compute V ..... ft/s				
18. Flow length, L ..... ft				
19. $T_t = \frac{L}{3600\,V}$ Compute T_t ..... hr		+		=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.10

Worksheet 4: Graphical Peak Discharge method

Project SUMMIT NATIONAL SUPERFUND SITE By ____ Date NOV/91

Location DEERFIELD/OHIO Checked ____ Date ____

Circle one: (Present) (Developed) EAST DITCH

1. Data:

Drainage area ..... A_m = 0.017 mi^2 (acres/640)

Runoff curve number .... CN = 74 (From worksheet 2)

Time of concentration .. T_c = 0.10 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ..... = ____ percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4		
4. Initial abstraction, I_a ..... (Use CN with table 4-1.)	in	0.703		
5. Compute I_a/P		0.176		
6. Unit peak discharge, q_u ..... (Use T_c and I_a/P with exhibit 4- II)	csm/in	950		
7. Runoff, Q ..... (From worksheet 2).	in	1.60		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)				
9. Peak discharge, q_p ..... (Where $q_p = q_u A_m Q F_p$)	cfs	25.84		

3.0 SITE COVER

3.1 PERMEABLE SITE COVER DESIGN

Data given and assumptions:

- required permeability 1 x 10-4 cm/sec or less;
- maximum aggregate size shall be 2 inches;

Check D_{10} criterion for given permeability:

Hazen formula $K - 0.01 \times D_{10}^2$

K - soil permeability m/s = 0.000001 m/s

D_{10} - particle size in mm, corresponding to 10% passing by weight (on particles distribution curve)

$$(\text{mm})\ D_{10} = \sqrt{\frac{0.000001}{0.01}} = 0.01 \text{ mm},$$

10% by weight shall be particle size of 0.01 mm or smaller.

Check permeability versus type of soil criterion:

required permeability of soil $K = 10^{-4}$ cm/s = 6.6 gal/day/ft^2 or less

According to Table V-1, sandy loam soil type, having permeability of 1 gpd/ft^2 should be considered as a basic soil type, for cover material application.

TABLE V-1 APPROXIMATE COEFFICIENTS OF PERMEABILITY

Approximate Particle Size and Permeability of Various Soils

Material	Particle size,* mm	Approximate permeability, gpd/sq ft
Clay	0.0001-0.005	10^{-6} to 10^{-2}
Silt	0.005-0.05	10^{-2} to 10
Very fine sand	0.05-0.10	10 to 50
Fine sand	0.10-0.25	50 to 250
Medium sand	0.25-0.50	250 to 1,000
Coarse sand	0.50-2.00	1,000 to 15,000

*1 mm = 0.03937 in.

Soil Types (U.S. Bureau of Soils)

Material	Clay, percent	Silt, percent	Sand, percent	Approximate permeability, gpd/sq ft
Clay	30-100	0-50	0-50	10^{-4}
Silty clay	30-50	50-70	0-20	10^{-3}
Sandy clay	30-50	0-20	50-70	10^{-3}
Silty clay loam	20-30	50-80	0-30	10^{-2}
Clay loam	20-30	20-50	20-50	10^{-2}
Sandy clay loam	20-30	0-30	50-80	10^{-2}
Silt loam	0-20	50-100	0-50	10^{-1}
Loam	0-20	30-50	30-50	10^{-1}
Sandy loam	0-20	0-50	50-80	1
Sand	0-20	0-20	80-100	Over 10

(To convert from gpd/sq. ft. to $m^3/s/m^2$ multiply by 44.383 957 x 10^{-12})

Source: Linsley, R. K. and J. B. Franzini, *Water Resources Engineering*, McGraw-Hill Book Co., New York, N.Y., 1972.

R. Allan Freeze
John A. Cherry
GROUNDWATER

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

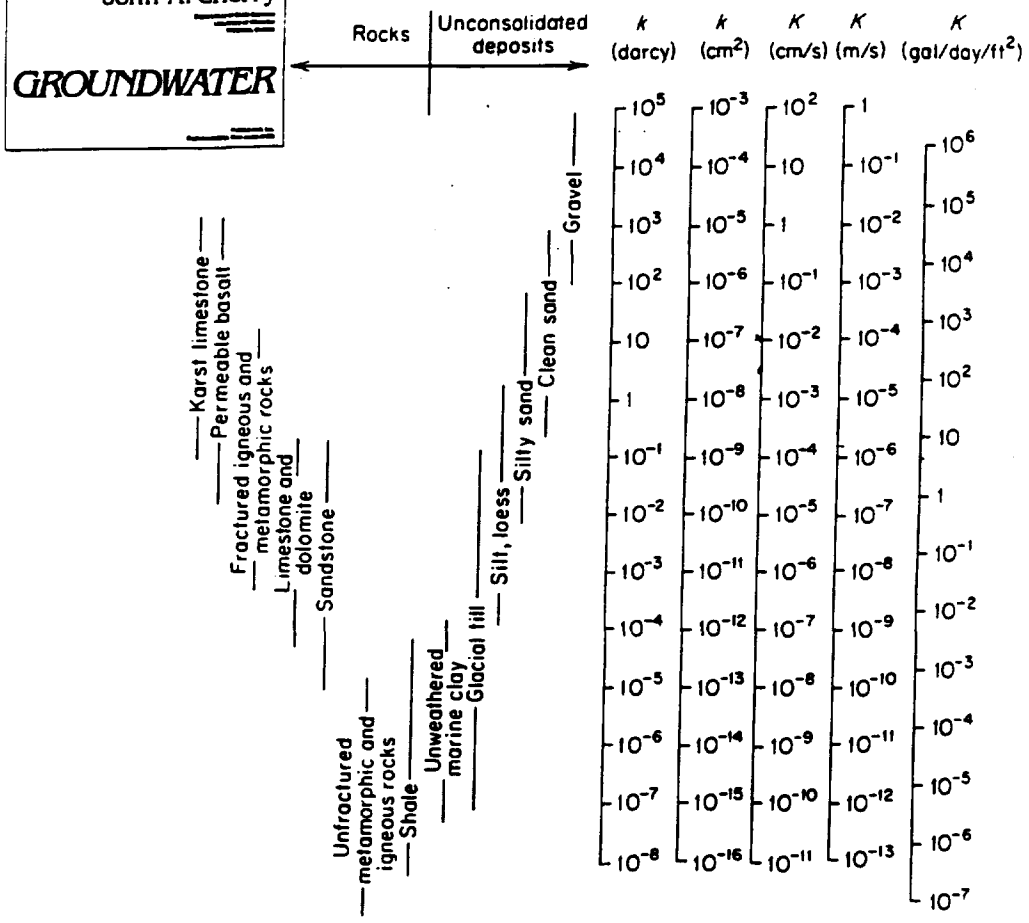
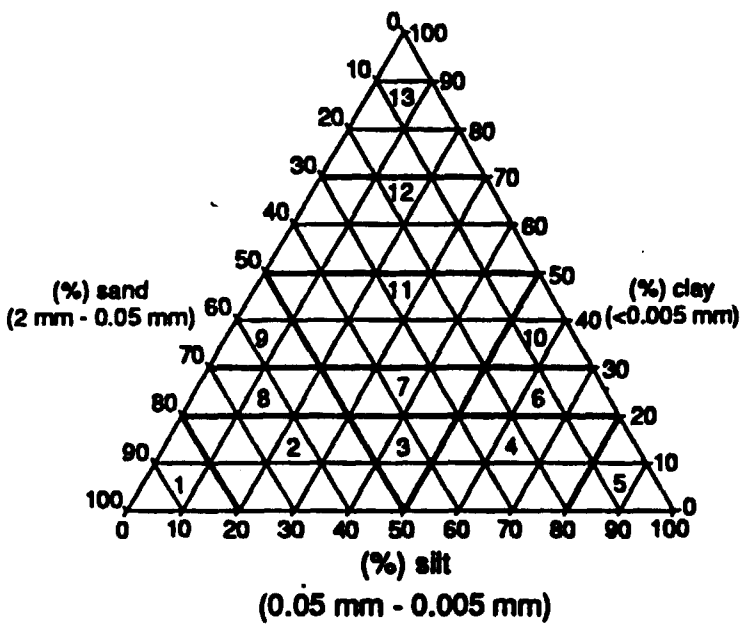


Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm^2	ft^2	darcy	m/s	ft/s	U.S. gal/day/ft^2
cm^2	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft^2	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft^2	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

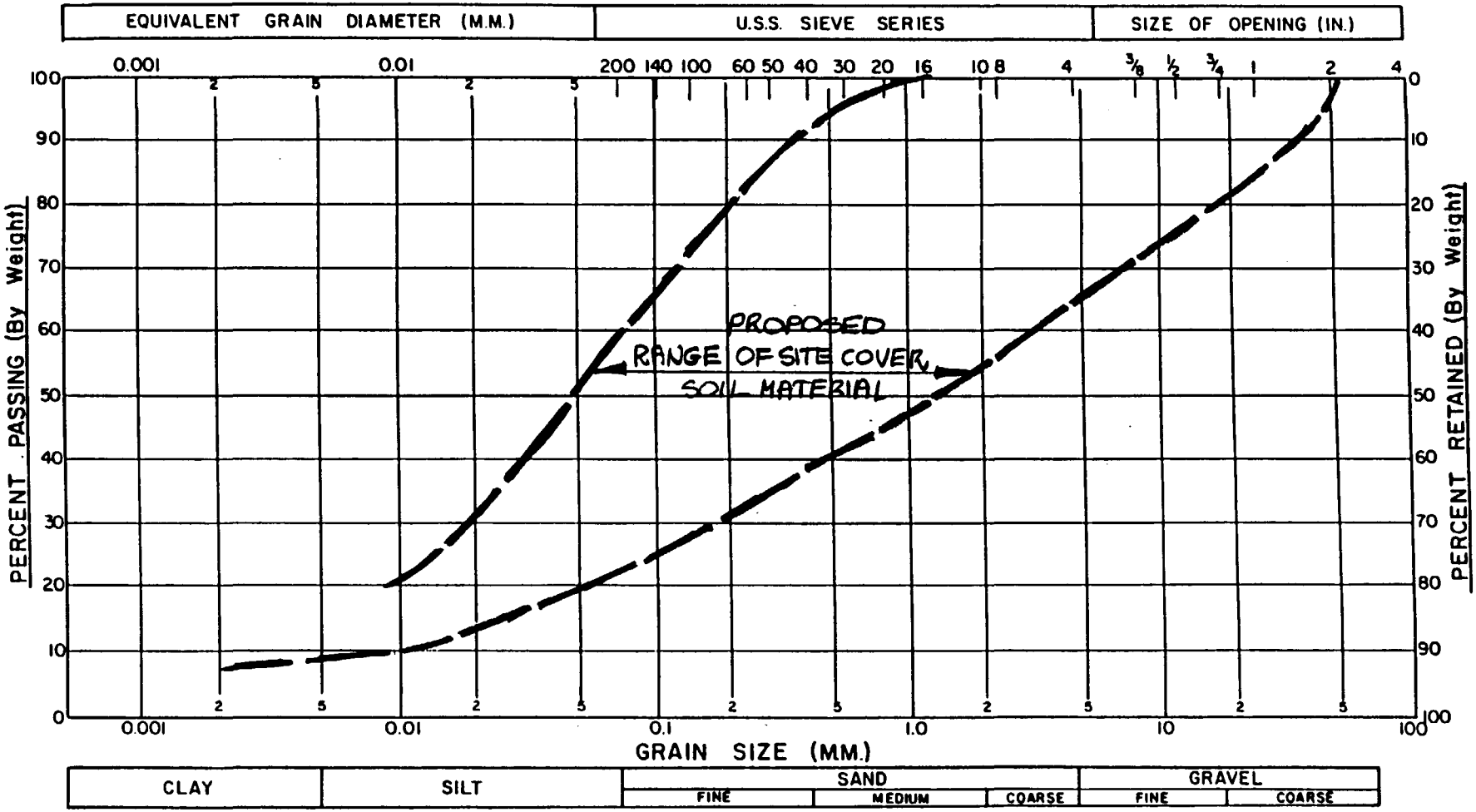
*To obtain k in ft^2, multiply k in cm^2 by 1.08×10^{-3}.



Textural Classification Chart

(U.S. Bureau of Soils Classification)

Textural Classification	(%) Clay	(%) Silt	(%) Sand
1 Sand	0 - 20	0 - 20	80 - 100
2 Sandy Loam	0 - 20	0 - 50	50 - 80
3 Loam	0 - 20	30 - 50	30 - 50
4 Silty Loam	0 - 20	50 - 80	0 - 50
5 Silt	0 - 20	80 - 100	0 - 20
6 Silty Clay Loam	20 - 30	50 - 80	0 - 30
7 Clay Loam	20 - 30	20 - 50	20 - 50
8 Sandy Clay Loam	20 - 30	0 - 30	50 - 80
9 Sandy Clay	30 - 50	0 - 20	50 - 70
10 Silty Clay	30 - 50	50 - 70	0 - 20
11 Light Clay	30 - 50	0 - 50	0 - 50
12 Medium Clay	50 - 70	0 - 50	0 - 50
13 Heavy Clay	70 - 100	0 - 30	0 - 30


EQUIVALENT GRAIN DIAMETER (M.M.)
U.S.S. SIEVE SERIES
SIZE OF OPENING (IN.)
0.001
0.01
200 140 100 60 50 40 30 20 16 10 8 4
3/8 1/2 3/4 1 2 4
PERCENT PASSING (By Weight)
PERCENT RETAINED (By Weight)
PROPOSED
RANGE OF SITE COVER
SOIL MATERIAL
GRAIN SIZE (MM.)
0.001
0.01
0.1
1.0
10
100
CLAY
SILT
SAND
FINE
MEDIUM
COARSE
GRAVEL
FINE
COARSE

CRA

The following gradation for soil cover material is proposed (see particle size distribution curve):

Clay	10%
Silt	30%
Sand	50%
Gravel	10%

Conclusion:

Proposed soil gradation for soil cover material shall be sandy loam type and shall have permeability of 1×10^{-4} or less.

3.2 SITE COVER VEGETATION - SPECIFICATION

Site cover vegetation work will include the following items:

Topsoil: loam soil, non-swelling, compactible material with permeability of 1×10^{-4} cm/sec.

Topsoil will be free from subsoil, roots, weeds, vegetation, toxic materials and debris.

Topsoil shall be free of lumps and stones exceeding 1 inch in any dimension.

Topsoil shall have pH ranging from 6 to 7.

Fertilizer: Minimum 65% insoluble nitrogen, formulation ratio 10-20-20, rate shall be 300 lbs/acre.

Lime: Shall be agricultural ground limestone containing minimum 85% of total carbonates grades as follows:

% Passing by Weight	Sieve Size
90%	No. 18
50%	No. 120

Grass Seed: Minimum germination of 75% and minimum purity of 97%.

Gross Mixture:	60% Kentucky Bluegrass 30% Creeping Red Fescue 10% Perennial Ryegrass
Seed Rate:	135 lb/acre

3.3 EVALUATE EROSION POTENTIAL

The USDA universal soil loss equation: $A = R K L S C P$

A - average annual soil loss, in tons/acre

R - rainfall and runoff erosivity index for Ohio = 150

K - soil erodibility factor, tons/acre = 0.34 for loam soil type with 2% organic matter content

LS - slope length and steepness factor
$LS = (0.34 \times 0.71 + 3.5 \times 1.29)\ 0.5 = 2.38$
based on two slope segments:
600 ft @ 2%
80 ft @ 20% (1:5)

C - cover management factor 0.01 (meadow, moderate productivity level)

P - practice factor = 1.0, no support practice

A - 150 x 0.34 x 2.38 x 0.01 x 1 = 1.21 tons/acre

less than maximum allowed of 2 tons/acre

3.4 ACCESS ROAD DESIGN

Given and assumptions:

- subgrade strength, CBR value between 0.5 to 0.75 (easily penetrated soil to penetrated with pressure, when saturated);
- 5,000-lb wheel load traffic (generally applies to cars and light trucks);
- filter fabric strength of 200 lbs (tensile strength);
- design based on conservative approach:
- required thickness of compacted aggregate will be not reduced due to filter fabric use.

According to Aggregate Depth Curve (see attached), required thickness of compacted aggregate, for conditions as above, will be of 12 inches approximate.

Proposed granular material size:

Screen Size	*% Passing by Weight*
2 in	100
1 in	70 - 90
3/4 in	50 - 80
#4	30 - 55
#200	3 - 10

Aggregate Selection

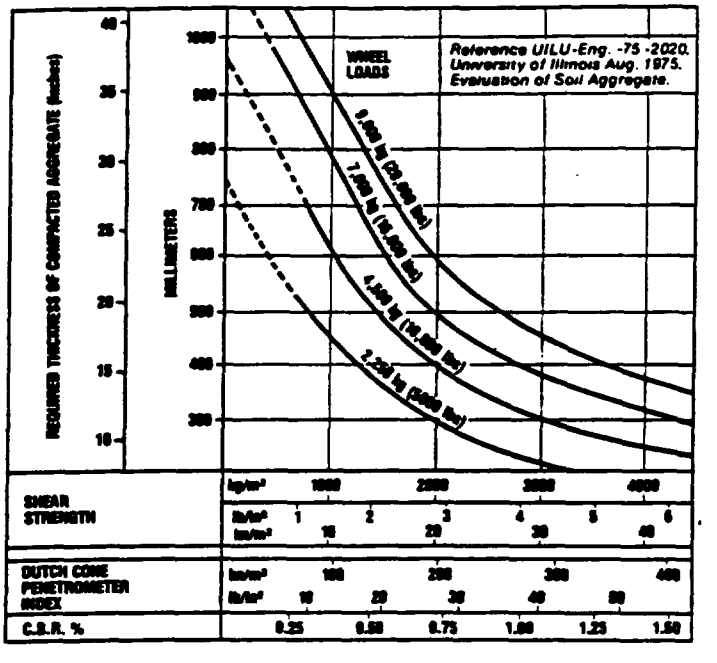
To properly select fill depth, three conditions must be examined.

1. *Soil strength.* Soil values should be assessed at maximum water saturation. Soaking the test point for 24 hours may be necessary for more accurate readings. The recommended methods, cone penetrometer or vane shear, are reliable and efficient.

2. Effective contact pressure is generally that of tire pressure.

3. *Maximum axle load.* Having determined the values, one may select aggregate depth required subject to the type of fill material used. See adjacent charts.

Aggregate Depth Curve



ATTACHMENT 1

MECHANICAL COMPONENTS

GROUNDWATER EXTRACTION SYSTEM

Mechanical Components

Reference No. 2372-20

SUMMIT NATIONAL
GROUNDWATER EXTRACTION
SYSTEM

POWER REQUIREMENTS
LIST OF ELECTRICAL COMPONENTS
GROUNDWATER EXTRACTION SYSTEM

ITEM	DESCRIPTION	QUANTITY	HP INSTALLED
	1. EXTRACTION WELLS		
P 101	1.1 ELECTR. SUBMERSIBLE PUMP, GRUNDFOS 5 E B ; 1/3 HP EACH 3-WIRE MOTOR; 230 VOLTS; SINGLE PHASE.	6	2
	1.2 WIRE SUSP. ELECTRODE TYPE E-1S C/W 1500 SERIES RELAY BY B/W CONTROLS	6×2=12	—
	1.3. FLOW CONTROL VALVE, HQ 99; 120V-8 WATTS	6	—
	1.4 WATER FLOW METER/TRANSMITTER 10-60 V DC.	6	—
	SUBTOTAL E.W. SYSTEM	—	2
	2. PIPE & MEDIA DRAIN-ACCESS MH		
	2.1 HIGH WATER LEVEL CONTROLS MODEL 7010 C/W 1500 RELAY, BY C/W CONTR.	5	—
		—	—
	3. WET WELL SYSTEM		
P 102	3.1 ELECTR. SUBMERSIBLE PUMP GRUNDFOS 60S20-4 ; 2 HP EACH 3 PHASE; 460 VOLTS.	2	4
	3.2 LIQUID LEVEL FLOAT SWITCH MODEL 7010 SERIES C/W 1500 RELAY BY B/W CONTROLS.	2×4=8	—
	3.3 FLOW CONTROL VALVE, HQ 99; 120V-8 WATTS	2	—
	3.4 WATER FLOW METER/TRANSMITTER 10-60 V DC.	2	—
	SUBTOTAL W.W. SYSTEM	—	4
	TOTAL GROUNDWATER EXTRACT. SYSTEM	—	6

LEGEND:

F — GROUNDWATER FORCEMAIN

EXTRACTION WELL & WET WELL LIQUID LEVEL CONTROL CABLES

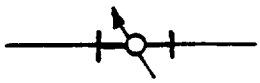
FLOW METER CABLES

POWER SUPPLY CABLES

ACCESS MANHOLE HIGH LEVEL/ ALARM CABLES

GATE VALVE

ELECTRIC FLOW RATE CONTROLER

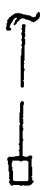


FLOW METER

ELECTRIC DRIVE SUBMERSIBLE PUMP GRUNDFOS MODEL 5E8-9, 1/3 HP, CAPACITY UP TO 7 GPM, TDH UP TO 250 FT. 3 WIRE MOTOR, 230 VOLTS, SINGLE PHASE; BUILT-IN CHECK VALVE

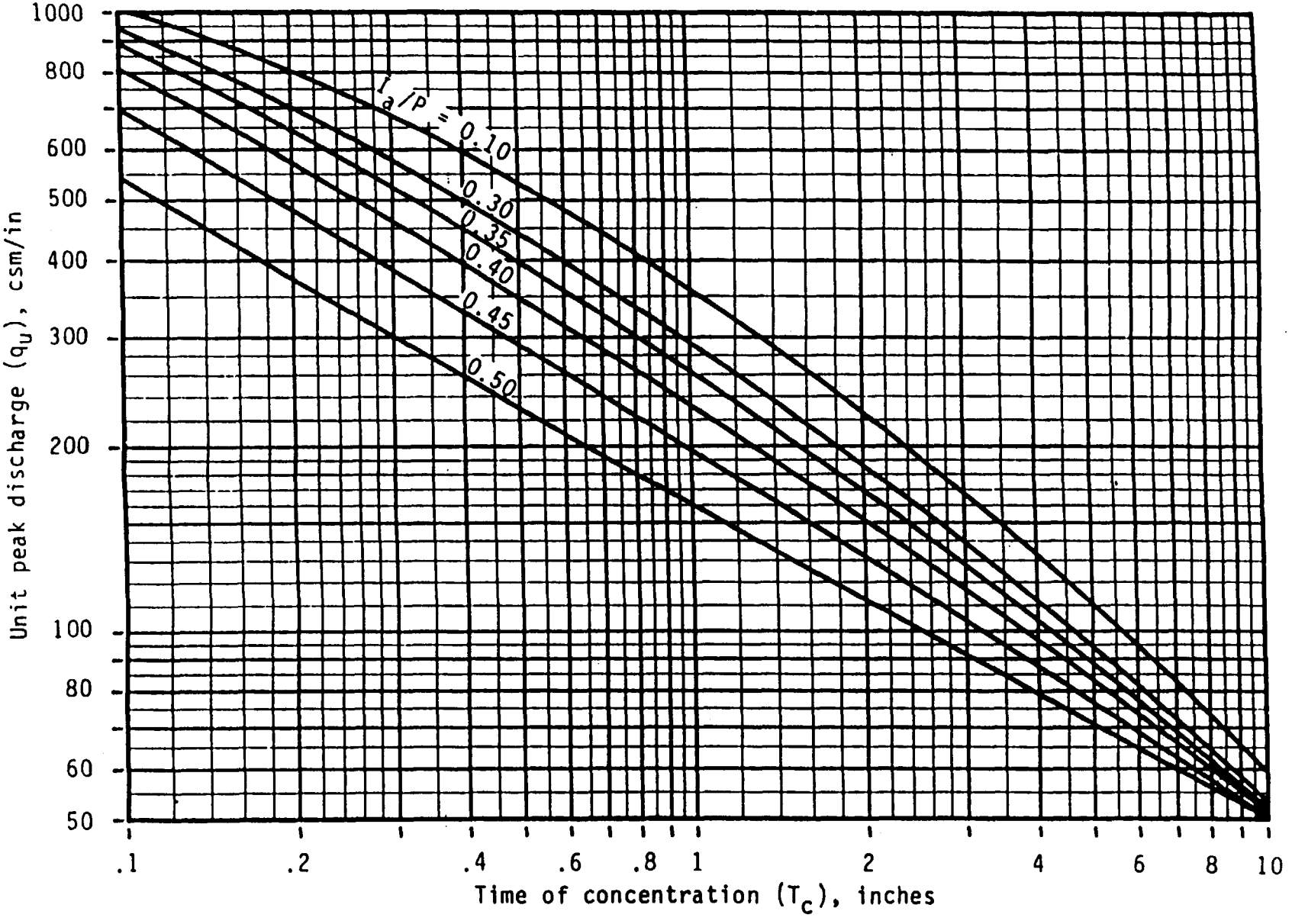
ELECTRIC DRIVE SUBMERSIBLE PUMP GRUNDFOS MODEL 60S20-9, 2 HP CAPACITY UP TO 50 GPM, TDH UP TO 110 FT, 3 PHASE 460 VOLTS, BUILT-IN CHECK VALVE.

LIQUID LEVEL FLOAT SWITCH



LIQUID LEVEL ELECTRODE

Exhibit 4-II: Unit peak discharge (q_u) . SCS type II rainfall distribution



EXTRACTION WELLS, 6 PUMPS POWER SUPPLY, 6 CABLES IN TWO 2"ϕ PVC CONDUIT

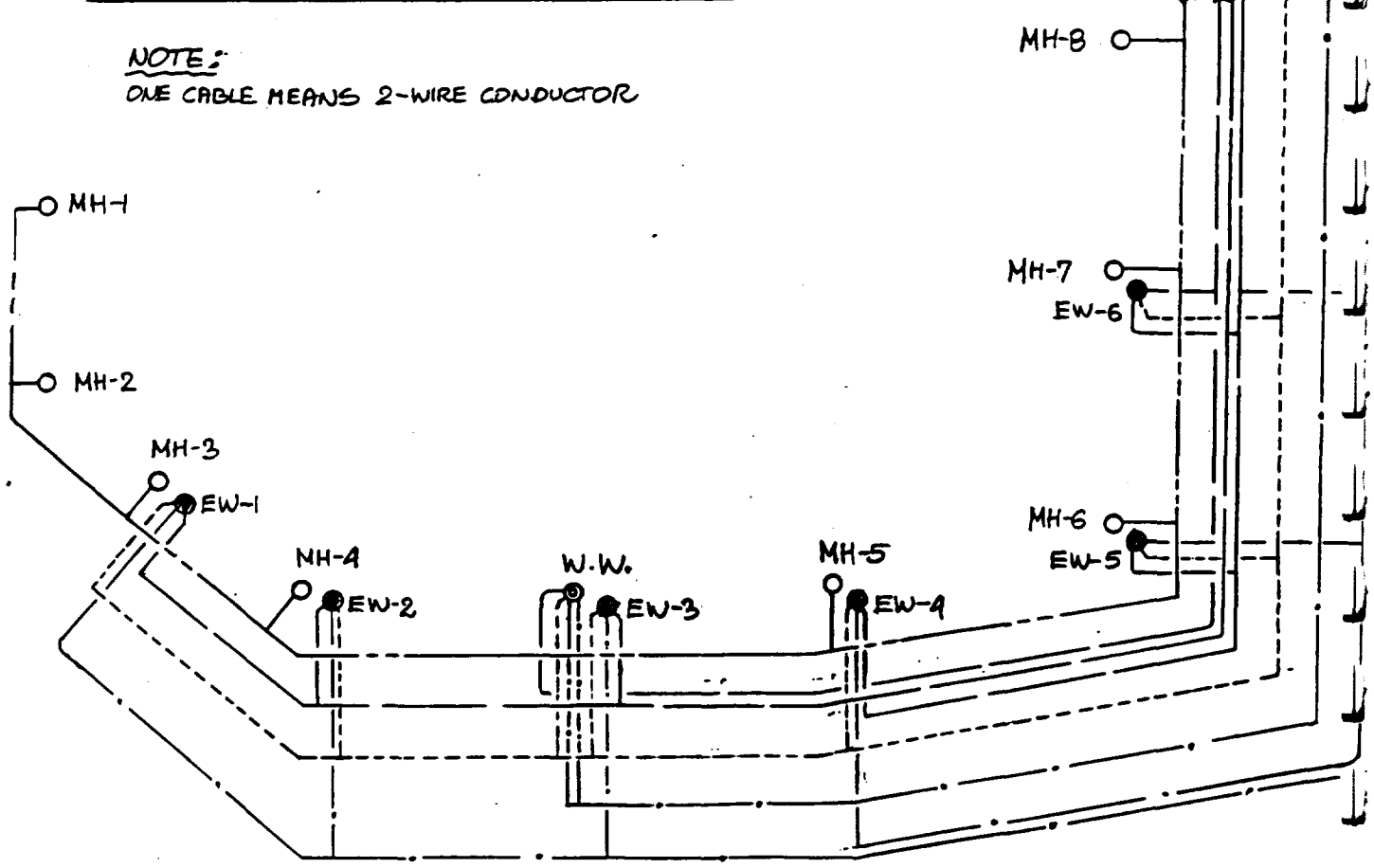
WET WELL 2 PUMPS POWER SUPPLY, 2 CABLES IN ONE 2"ϕ PVC CONDUIT

EXTR. WELLS & WET WELL, 7 FLOW METERS 7x1 CABLES, IN ONE 2"ϕ PVC CONDUIT

EXTRACTION WELLS & WET WELL 16 LIQUID LEVEL CONTR. 6x2 CABLES + 4 W.W. CABLES IN THREE 2"ϕ PVC CONDUITS

PIPE & MEDIA DRAIN ACCESS MH, 8 HIGH WATER LEVEL CONTROLS, 8 CABLES IN ONE 2"ϕ PVC CONDUIT.

NOTE:
ONE CABLE MEANS 2-WIRE CONDUCTOR

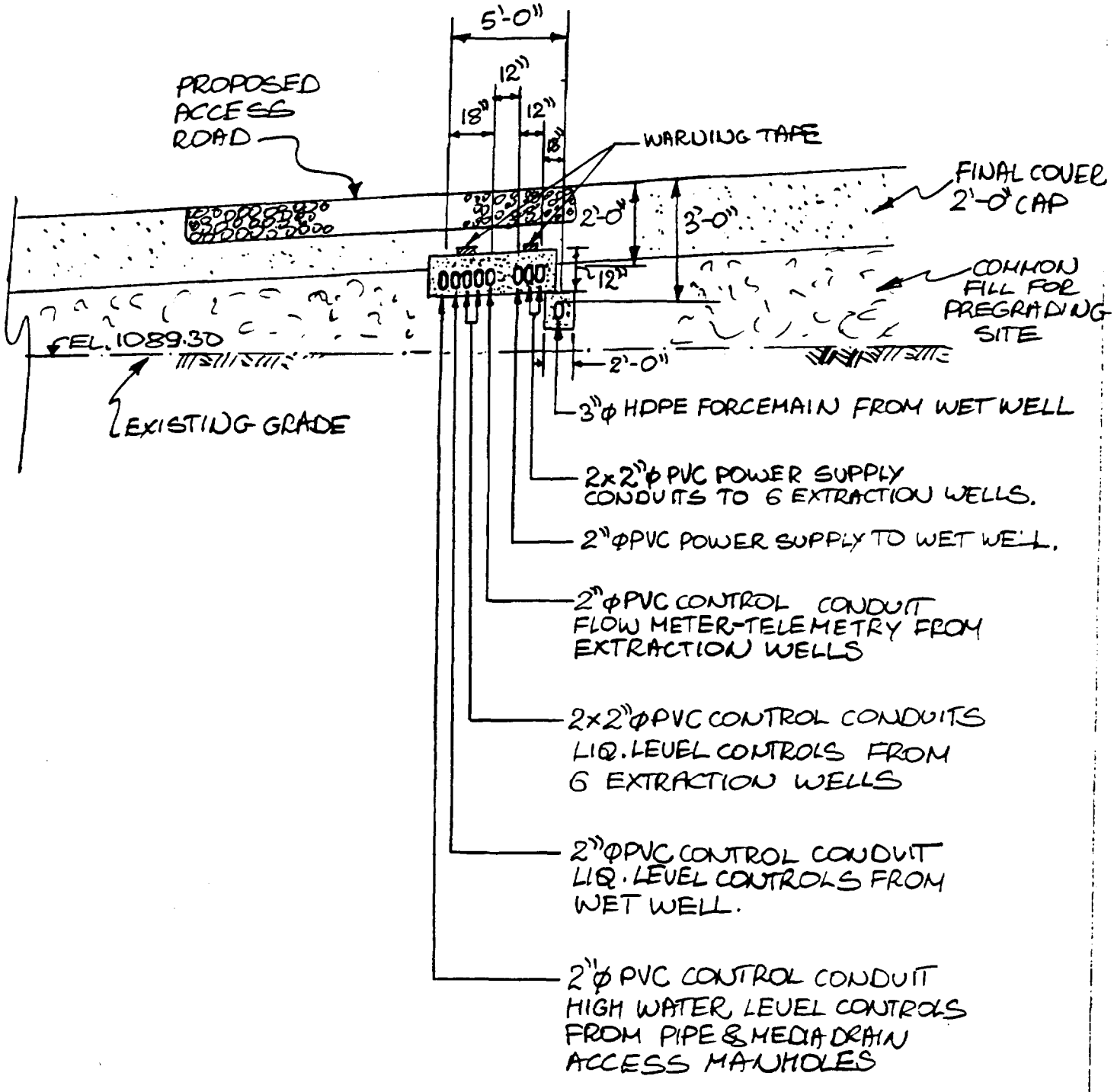


CONDUIT SCHEDULE

CRA
CONESTOGA-ROVERS & ASSOCIATES

PROJECT No. 2372
PROJECT NAME
DATE AUG. 24/02

DESIGNED BY A.W.
CHECKED BY
PAGE ____ OF ____



SECTION A-A'

N.T.S.

PIPE MATERIAL SPECIFICATIONS:

(1) STEEL PIPE SHALL BE SEAMLESS, TYPE S, GRADE A; CARBON STEEL, ACCORDING TO ASTM-A53, AND SHALL BE GALVANIZED, SCHEDULE 40.

(2) FORCEMAIN SHALL BE HIGH DENSITY POLYETHYLENE PIPE MATERIAL CONFORMING TO ASTM D-3350 AND SHALL BE CLASSIFIED AS PE 355434C.

HDPE PIPE SERIES SHALL BE DR-11, ACCORDING TO ASTM F-714.

PIPE FITTINGS SHALL BE BUTT-FUSHION, MOLDED FITTINGS ACCORDING TO ASTM D 3261.

PIPE JOINING METHOD SHALL BE THERMAL BUTT-FUSHION ACCORDING TO ASTM D-2657.

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-P1

NAME EXTRACTION WELL SUBMERSIBLE PUMPS

LOCATION EXTRACTION WELLS

MANUFACTURER Grundfos Pump Corporation

DISTRIBUTOR Central Pump
Dayton, Ohio
513-890-1206

DESCRIPTION Model 5E8; 1/3 HP; 3 wire Motor; 230 Volts; single phase; built in check valve

MAINTENANCE

COMPONENT PARTS

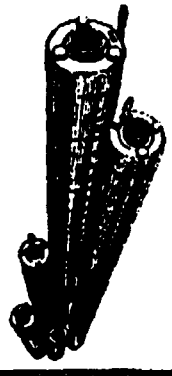
SPARE PARTS

GRUNDFOS

Redi-Flo Environmental Submersible Pumps

5E

Submittal Data 3450 RPM 60 Cycle



JOB or CUSTOMER:

ENGINEER:

CONTRACTOR:

SUBMITTED BY: DATE:

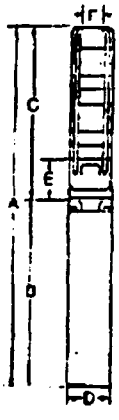
APPROVED BY: DATE:

ORDER NO.: DATE:

SPECIFICATION REF.:

QUANTITY	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENT

Dimensions



Technical Data

FLOW RANGE: 1.2 to 7 US GPM

MOTORS: Grundfos MS402E Environmental Submersible Motor (Standard)
Maximum Operating Temperature: 104°F (40°C)
Maximum Operating Pressure: 220 PSI
Maximum Number of Starts Per Hour: 100
Minimum Recommended Flow Past Motor: 0.25 ft/sec
(NOTE: Franklin Pollution Recovery motor is optional.)

DISCHARGE SIZE: 1" NPT

PUMP END CONSTRUCTION MATERIALS: Stainless Steel and Teflon®

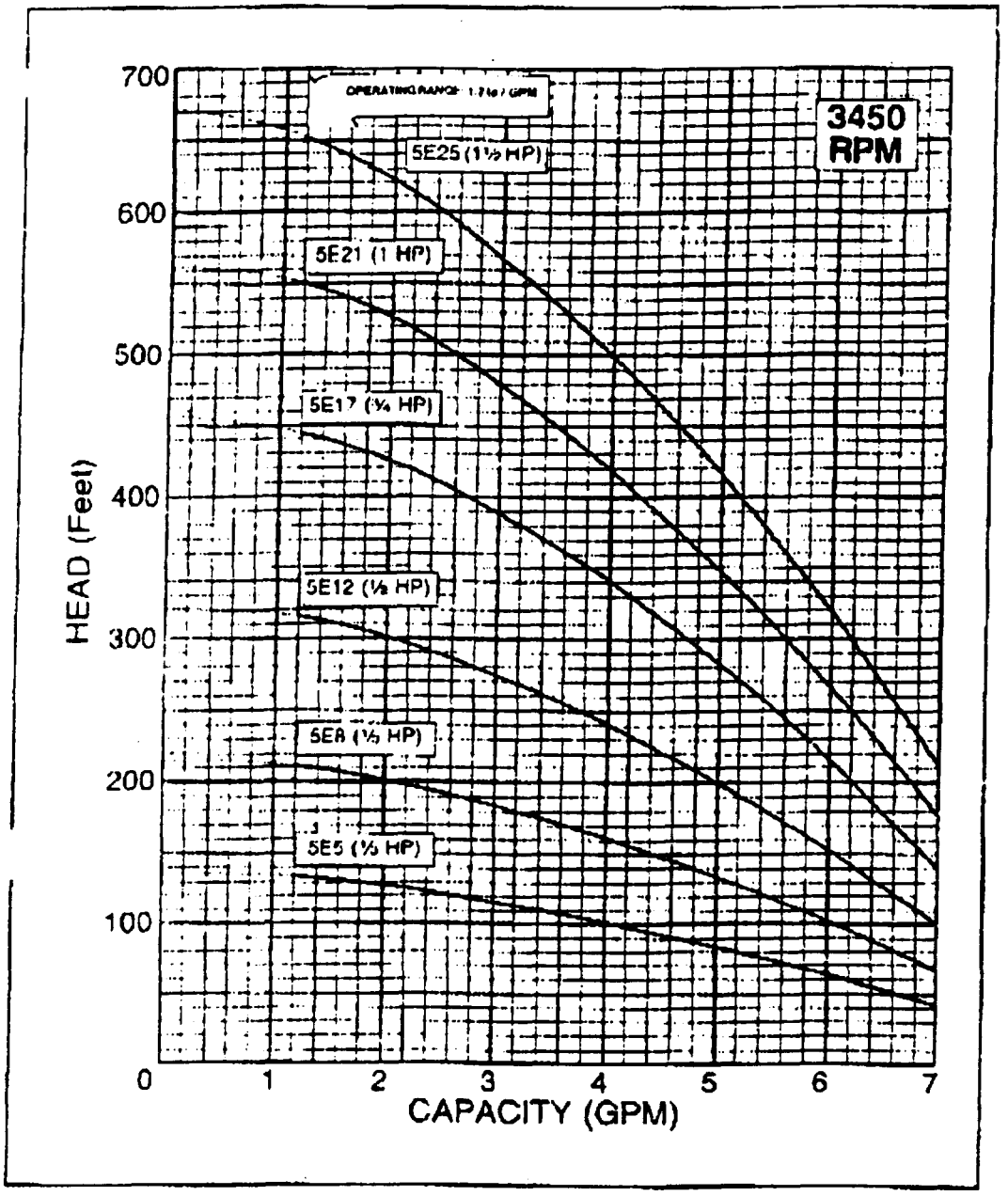
INSTALLATION: Unit to be installed vertically for submerged operation.

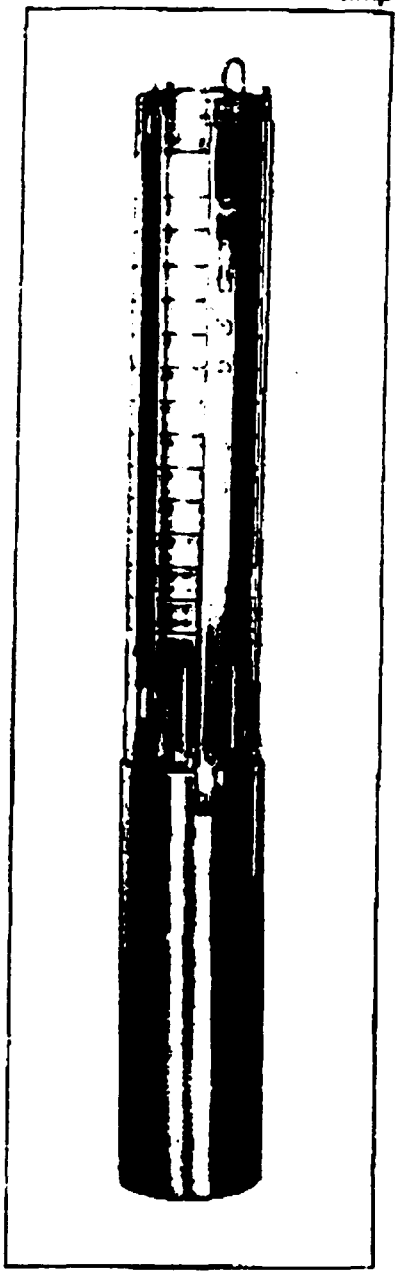
Electrical Data, Dimensions, and Weights ①

PUMP TYPE	MOTOR HP	MOTOR SF	MOTOR PH	MOTOR VOLTS	DIMENSIONS (in inches) OVERALL LENGTH A	MOTOR LENGTH B①	PUMP END LENGTH C	MAX. DIA. D	INLET E	DISCH. PIPE SIZE (NPT) F	NET WEIGHT (LBS.)②	SHIP. WEIGHT (LBS.)②
5E8	⅓	1.75	1	230	22 ¾	10	12 ¾	3 ³⁵/₆₄	3 ¼	1	26	28
5E17	¾	1.50	1	230	31 ⁷/₁₆	11 ⅛	20 ⁵/₁₆	3 ⁹/₃₂	3 ¼	1	31	32
5E25	1 ½	1.30	1	230	40 ⁵/₁₆	13 ⁹/₁₆	26 ¾	3 ³⁵/₆₄	3 ¼	1	35	37

① Data for Grundfos MS402E motors. ② Does not include motor leads.

Performance Curves





Materials of Construction

REDI-FLO PUMP END	
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	304 Stainless Steel & Teflon®
Diffuser Chamber	304 Stainless Steel
Impeller Seal Ring	Teflon®
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	304 Stainless Steel
Coupling	329/420/431 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
ermodiate Bearings	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR	
Nema Top	304 Stainless Steel
Studs & Fasteners	304 Stainless Steel
Nuts	316 Stainless Steel
Sand Slinger	Viton®
Shaft Extension	431 Stainless Steel
Diaphragm	Viton®
Stator Housing	304 Stainless Steel
Fill Plug Screw	304 Stainless Steel
Fill Plug Washer	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR LEADS	
Connector Sleeve	304 Stainless Steel
Connector Potting	Scotch Guard #3® Epoxy w/Viton® Cap
Connector Plug	Viton®
Lead Insulation	Teflon®

...TF Specifications are subject to change without notice.

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X1

NAME EXTRACTION WELL PITLESS ADAPTERS

LOCATION EXTRACTION WELLS

MANUFACTURER Maas - Division of Surinak
Engineering and Manufacturing, Inc.

DISTRIBUTOR Muskego Industrial Park
S82 W19246 Apollo Drive
Muskego, WI 53150
414-679-3922

DESCRIPTION Model-J Weld on Type, Drop Pipe Size 1 in. Dia.
for 8 in. well casing

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

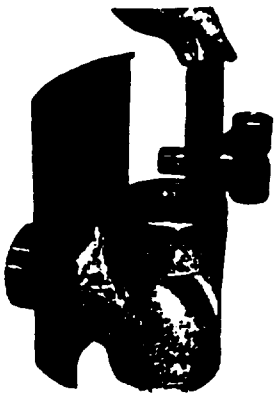
MAASS PITLESS ADAPTERS

— A full range of weld-on adapters from 1 to 4 inch

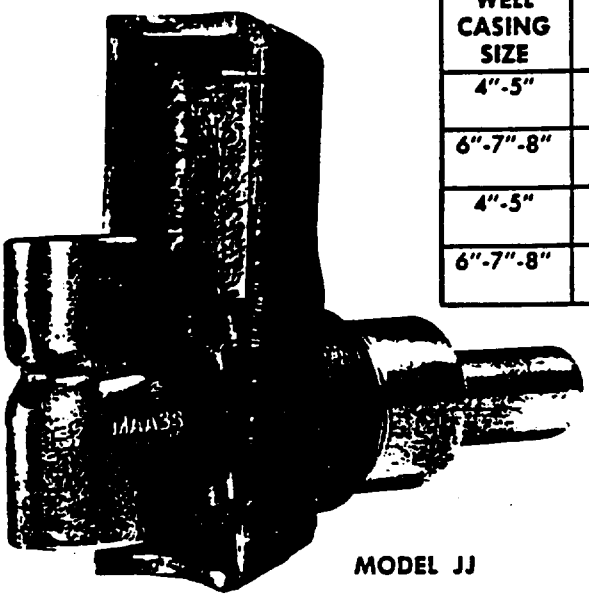
WISCONSIN STATE APPROVED
MICHIGAN STATE APPROVED
PATENTED

MAASS MODEL J PITLESSES ARE SANITARY AND EASY TO SERVICE

Recommend to your customers the Maass Model J pitlesses — units create easy well service for you because they are manufactured only of RUST-PROOF materials and designed to eliminate all obstructions in well casing. Pump is easy to pull because of non-rusting components. Water contacts only 304 stainless steel and bronze to COMPLETELY ELIMINATE ANY RUST and/or ELECTROLYSIS. The Maass pitless connection is sealed by using a bronze 8 degree non-locking taper wedge with O-ring force against 304 non-magnetic stainless steel flanged nipple pressed into steel housing and welded on outer side. Model J Pitless Adapter is non-pressure lifting and is designed for deep wells, higher working pressures, and where plastic pipe is used and high water levels. No lock necessary. Stock only two 1-inch outlet size Maass Model J pitlesses to fit all well casing sizes. Pitless steel housing is permanently installed by welding onto well casing.



MODEL J



MODEL JJ

MODEL JJ

MODEL JJ models below are for suction pumps. Lateral can be pressurized to meet state codes.

WELL CASING SIZE	MODEL	WATER OUTLET & DROP PIPE SIZE
4"-5"	JJ	1" outlet 2" lateral
6"-7"-8"	JJ	1" outlet 2" lateral
4"-5"	JJ	1¼" outlet 2" lateral
6"-7"-8"	JJ	1¼" outlet 2" lateral

WELD-ON UNITS

WELL CASING SIZE	MODEL	WATER OUTLET & DROP PIPE SIZE	APPROXIMATE WEIGHT
4"-5"	J	1"	6#
4"-5"	J	1¼"	7#
4"-5"	J	1½"	8.5#
5"	J	2"	12#
6"-7"-8"	J	1"	6#
6"-7"-8"	J	1¼"	7#
6"-7"-8"	J	1½"	8.5#
6"-7"-8"	J	2"	12#
6"-7"-8"	J	2½"	18#
8"-10"-12"	J	3"	32#
10"-12"	J	4"	50#

SEE YOUR DISTRIBUTOR OR REPRESENTATIVE FOR ADDITIONAL INFORMATION

MAASS
Division of Surmak Engineering & Manufacturing, Inc.
MUSKEGO INDUSTRIAL PARK
S82 W19246 Apollo Drive
Muskego, WI 53150
(414) 679-3922

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-V2

NAME EXTRACTION WELL GATE VALVES

LOCATION EXTRACTION WELLS

MANUFACTURER Watts Regulator Company

DISTRIBUTOR Disney-McLane Inc.
2704 Colerain Ave.
Cincinnati, Ohio
513-541-1682

DESCRIPTION Series WGV, brass body, threaded connections,
1 in. dia.

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

bronze and brass gate valves

Complies with Federal Specification WW-V-54,
Type I, Class A, 85-5-5-5 construction

Series FGV-1

Federal Specification MSS SP-80
Inside screw bonnet, NRS, solid disc

(I)

Designed for continuous service on steam, water, oil and gas in either the open or fully-closed position. They are ideally suited for areas where space is a premium. Virgin PTFE packing and a gland follower. ASTM B62 body, stem and disc. Threaded IPS connections.

Pressure rating: 200 WOG
Steam rating: 125 W.S.P.

No.	Size	Dimensions (Inches) A	B	C	Master Carton Qty.	Weight (lbs.)
FGV-1, FGVS-1*	1/4"	1.66	3.05	1.88	120	60
FGV-1, FGVS-1*	3/8"	1.66	3.05	1.88	120	60
FGV-1, FGVS-1*	1/2"	1.96	3.29	2.44	96	74
FGV-1, FGVS-1*	3/4"	2.05	3.92	2.75	48	62
FGV-1, FGVS-1*	1"	2.48	4.46	2.75	42	74
FGV-1, FGVS-1*	1 1/4"	2.60	5.24	3.35	24	64
FGV-1, FGVS-1*	1 1/2"	2.77	5.59	3.74	15	46
FGV-1, FGVS-1*	2"	2.96	6.38	4.13	10	45

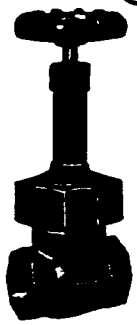
*FGVS-1 solder end connections

For Additional Information, send for F-BBV, GV, CV

Series FGV-UB

Federal Specification MSS SP-80
Union bonnet, rising stem, solid disc

(I)



Designed for continuous service on steam, water, oil and gas in either the open or fully-closed position. They afford free flow with minimum pressure drop. The union bonnet provides for quick valve disassembly for inspection and repair plus it reinforces the body to protect against vibration and pipeline strain. Virgin PTFE packing and a gland follower.

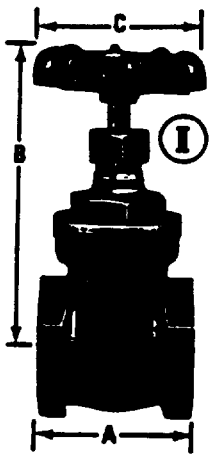
Pressure rating: 300 WOG
Steam rating: 150 W.S.P.

No.	Size	Dimensions (Inches) A	B	C	Master Carton Qty.	Weight (lbs.)
Threaded IPS connections						
FGV-UB	1/4"	1.75	4.13	1.88	120	60
FGV-UB	3/8"	1.75	4.13	1.88	120	60
FGV-UB	1/2"	2.13	5.00	2.44	96	74
FGV-UB	3/4"	2.24	6.10	2.75	48	62
FGV-UB	1"	2.62	7.56	2.75	42	74
FGV-UB	1 1/4"	2.87	8.62	3.35	24	64
FGV-UB	1 1/2"	3.13	10.04	3.74	15	46
FGV-UB	2"	3.52	12.13	4.13	10	45

For Additional Information, send for F-BBV, GV, CV

Series GV, GVS

Bronze Gate Valves
For Water and Steam Service



(I)

Full rating for broad application.
125 WSP, 200 psi WOG.

Series GV have IPS threaded connections in sizes 1/4"- 4".

Series GVS have CxC sweat connections in sizes 3/8"- 3".

- Screw-in bonnet
- 85-5-5-5 bronze body

Size	DIMENSIONS (Inches) A GV	A GVS	B GV	B GVS	C GV	C GVS	Weight (lbs.) GV	Weight (lbs.) GVS
1/4"	15/8	–	3	–	1 15/16	–	0.62	–
3/8"	15/8	1 3/4	3 3/16	3 3/8	1 15/16	2 1/8	0.62	0.62
1/2"	1 3/4	1 3/4	3 3/8	3 3/8	2 3/16	2 1/8	0.71	0.62
3/4"	1 15/16	2 3/8	3 5/8	3 5/8	2 3/8	2 3/8	0.93	0.88
1"	2 1/8	2 13/16	4 7/16	4 7/16	2 9/16	2 9/16	1.2	1.15
1 1/4"	2 3/8	3	5	5	2 3/4	2 3/4	2.0	1.72
1 1/2"	2 1/2	3 3/8	5 3/8	5 7/16	3 1/8	3 1/8	2.7	1.85
2"	2 7/8	4	6 1/2	6 1/2	3 9/16	3 1/2	3.4	3.53
2 1/2"	3 1/2	4 1/2	8	8 5/16	4 5/16	4 3/8	6.4	5.95
3"	3 15/16	5 3/16	9 3/16	9 3/16	4 15/16	4 15/16	9.3	8.82
4"	4 3/4	–	10 3/4	–	5 3/4	–	18.0	–

For Additional Information, send for F-BBV, GV, CV.

Series WGV, WGVS

Brass Gate Valves

(I)

Rating: 200 psi WOG

Series WGV have IPS threaded connections in sizes 1/2"- 4".

Series WGVS have CxC sweat connections in sizes 1/2"- 2".

Size (Inches)	DIMENSIONS (Inches) A WGV	A WGVS	B WGV	B WGVS	C WGV	C WGVS	Weight (lbs.) WGV	Weight (lbs.) WGVS
1/2	1 3/4	1 15/16	3	3	2 1/8	2 1/8	.60	.58
3/4	1 15/16	2 1/2	3 1/2	3 1/2	2 1/8	2 1/8	.82	.80
1	2 1/8	2 3/4	4 1/8	4	2 3/8	2 3/8	1.1	1.
1 1/4	2 3/8	3	4 1/2	4 1/2	2 1/2	2 3/4	1.37	1.33
1 1/2	2 3/8	3 1/2	5 3/8	5 1/8	2 3/4	2 3/4	2	2
2	2 13/16	4 1/4	6	6	3 1/4	3 1/4	3	3
2 1/2	3 1/2	—	7 3/4	—	4	—	6.25	—
3	3 7/8	—	8 7/8	—	4 7/16	—	7.75	—
4	4 3/4	—	10 1/2	—	5 1/8	—	13.50	—

For Additional Information, send for S-WGV.

(I) International Product

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X3

NAME EXTRACTION WELL ELECTRODES

LOCATION EXTRACTION WELLS

MANUFACTURER Magnetek Controls, B/W Controls

DISTRIBUTOR Nelcor Inc.
5169 Wooster Pike
Cincinnati, Ohio 45226
513-871-2816

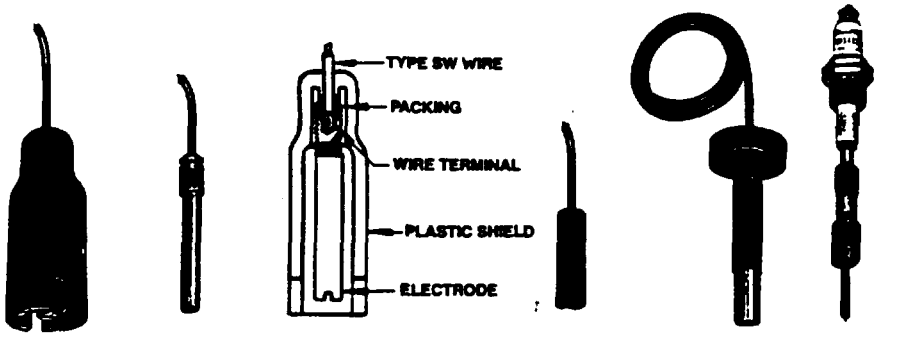
DESCRIPTION Wire suspension electrode
Type E-1S with shield, brass material complete with cord grip electrode holder, Type SW suspension wire and 1500 series induction relay

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

WIRE SUSPENSION ELECTRODES



E-1P WITH SHIELD | E-1P LESS SHIELD | E-1P CUT-AWAY | E-1S WITH SHIELD | 13-064700 | PLUG WITH CONNECTOR

Wire suspension electrodes are designed for use in applications requiring long lengths, or where limited head room prevents installation of solid rod electrodes. They can be used with all holders except Type CE-2 & 3. Electrode Types E-1P and E-1S are for use in water and non-corrosive liquids. Type 13-064700 is designed for corrosive liquids and is available with a variety of rod materials. Types E-1P and E-1S electrodes with molded plastic shields can be used at temperatures up to 150°F and other electrodes up to 190°F.

Type E-1P-Shielded: This electrode is approximately 4" long and assembled in a molded plastic insulating shield 1 7/16" in diameter. Designed for general purpose use, it is ideal for elevated tanks, sewage pumping stations, and deep well installations.

Type E-1P — Less Shield: This electrode is intended for applications where space prevents the use of other electrodes and where vertical spacing between electrodes is 4" or more.

Type E-1S-Shielded: A 2" long electrode assembled in a molded plastic shield 9/16" in diameter. Ideal for use in submersible pump installations and other applications where little clearance is provided for installation.

Type 13-064700: This electrode is intended for corrosive liquids. It is 3" long made from a ½" diameter rod and available in any of the materials listed below. The type SW wire is attached at the factory and the connection is completely sealed with PVC and bonded to the insulation of the SW wire.

WIRE CONNECTOR: This adapter is necessary to attach the Type SW suspension wire to the ¼-20 female electrode holder connections. One is required for each wire suspension electrode used with electrode plugs, and Type E and Type AE-2 holders. See pages 6 & 7.

CATALOG NUMBER
6013 — C — BR

Material		LIST PRICE
Brass Old No. 12-038400	BR	$3.80
303 SS Old No. 12-043800	SS	$6.80

Type SW Suspension Wire: Designed to provide maximum strength and insulation, Type SW wire should always be used with BIW wire suspension electrodes to assure that a watertight seal is accomplished by the packing in the electrode. The wire is single conductor 18 gauge, 41 strand copper with 4/64" vinyl insulation.

CATALOG NUMBER
6013 — SW — 10

		LIST PRICE
Specify Length In Feet Old No. 01-130500		$0.60 per ft.

6013 — W1

CATALOG SECTION	ELECTRODE TYPE	ELECTRODE MATERIAL	OLD PART NO.	LIST PRICE
W1	E-1P With Shield	Brass	13-020600	$11.80
W2	E-1P With Shield	303 Stainless	13-020700	17.20
W3	E-1P Less Shield	Brass	13-052700	4.80
W4	E-1P Less Shield	303 Stainless	13-052600	9.80
W5	E-1S With Shield	Brass	13-022000	10.00
W6	E-1S With Shield	303 Stainless	13-024300	13.00

These electrodes are field assembled and the required amount of Type SW wire must be ordered as a separate item. See above.

NOTE — When wire suspension electrodes are to be used with electrode plugs, or Type E or Type AE-2 electrode holders, wire connectors must also be ordered for each electrode. See above.

6013 — W7 ——— 10

CATALOG SECTION	ELECTRODE TYPE	ELECTRODE MATERIAL	OLD PART NO.	LIST PRICE
W7	13-064700 With SW Wire	316 Stainless	13-064702	$48.00
W8	13-064700 With SW Wire	Monel	13-064703	50.00
W9	13-064700 With SW Wire	Nickel	13-064704	50.00
W10	13-064700 With SW Wire	Carpenter 20	13-064705	49.00
W11	13-064700 With SW Wire	Hastelloy B	13-064707	62.00
W12	13-064700 With SW Wire	Hastelloy C	13-064706	58.00
W13	13-064700 With SW Wire	Titanium	13-064709	58.00

		LIST PRICE
	Type SW Wire Length In Feet	ADD $.60 per ft.

These electrodes come complete with the Type SW wire permanently attached to the electrode. Lengths must be specified when ordering.

ELECTRODE HOLDERS AND ELECTRODES

MagneTek Controls B/W Controls

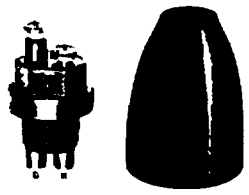
MOLDED ELECTRODE HOLDERS

Type AE-2 with rod electrodes

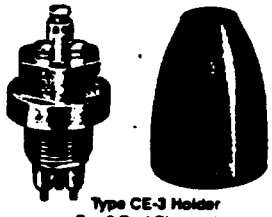
Type CE-2 & CE-3 Holders — *These small holders* are primarily for use in original equipment applications where available space is limited and where desired level control can be obtained with two or three short solid rod electrodes. They are furnished with a flexible PVC water-tight cover to protect lead wire junctions.

A choice of two thermoplastic materials is available with ratings as shown below. Pressure seal is accomplished with a Buna N gasket included with each holder. They have 303SS studs with 6-32 male thread for electrode connections.

HOLDER MATERIAL	MAXIMUM RATINGS
Butyrate	200 psi @ 100°F (38°C) 160°F (71°C) @ 0 psi
Nylon	200 psi @ 200°F (93°C) 350°F (177°C) @ 0 psi



Type CE-2 Holder
For 2 Rod Electrodes
1"-14 Straight Machine Thread



Type CE-3 Holder
For 3 Rod Electrodes
1"-14 Straight Machine Thread

CATALOG NUMBER 6012 — CE2B

	Holder Material	Old Part Number	LIST PRICE
CE2B	Butyrate	12-053600	$24.00
CE2N	Nylon	12-082500	31.00

CATALOG NUMBER 6012 — CE3B

	Holder Material	Old Part Number	LIST PRICE
CE3B	Butyrate	12-073500	$34.00
CE3N	Nylon	12-082700	43.00

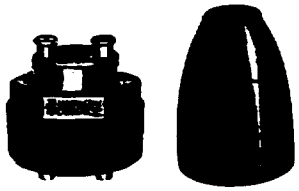
NOTE: The required Type 6B rod electrodes must be ordered as separate items. See Catalog Section 6013 page 13. Maximum recommended bare rod length is 12 inches.

Not available for wire suspension electrodes.

Type AE-2 Holders — Molded of ABS corrosion-resistant thermoplastic material, these holders are ideal for use in applications involving control of many corrosive liquids. Designed to permit the use of either two solid rod or two wire suspension electrodes, they are supplied with flexible PVC water-tight covers to protect the lead wire junctions.

They have 303SS couplings with ¼-20 female thread for electrode connections.

MAXIMUM RATINGS
250 psi @ 100°F (38°C) 180°F (82°C) @ 0 psi



TYPE AE-2 HOLDER

For 2 Rod or Wire Suspension Electrodes
2" NPT Pipe Thread Mounting

	LIST PRICE
Catalog No. 6012-AE2 Old Part No. 12-034500	$48.00

NOTE: The required electrodes must be ordered as separate items, see Catalog Setion 6013 for information.

Rod Electrodes — Type A rods are used see page 13.

Wire Suspension Electrodes — A wire connector is required for each wire suspension electrode, see page 12.

CONDUIT ELECTRODE HOLDERS

Designed for use with BIW wire suspension electrodes, these versatile low-cost holders are recommended for underground drainage sumps, septic dosing tanks, open sumps and similar applications. Available in cadmium plated cast iron for general purpose applications, or rigid polyvinyl chloride for corrosive situations.

These holders are mounted by attaching to a length of standard conduit extending over the liquid being controlled. They have grommets for each wire suspension electrode, and come in two sizes to accomodate up to eight electrodes.

CATALOG NUMBER 6012 ——— C4I

	No. of Electrodes	Holder Material	Conduit Size	Connection Type	Old Part Number	LIST PRICE
C4I	1-4	Cast Iron	½" NPT	Threaded	12-056900	$27.00
C4P	1-4	PVC	½" PVC	Cement	12-065400	27.00
C8I	1-8	Cast Iron	1" NPT	Threaded	12-061800	36.00
C8P	1-8	PVC	1" PVC	Cement	12-061900	36.00

NOTE: The required wire suspension electrodes must be ordered as separate items. See Catalog Section 6013, page 14 for ordering information

CORD GRIP ELECTRODE HOLDERS

Type CG1 with E-IP Electrode

BIW cord grip electrode holders provide a simple, low-cost means of sealing lead wire openings against leakage of gases and liquids in non-pressure applications requiring use of wire suspension electrodes. These include submersible pump installations with low level cutoff control, underground water storage tanks, covered sumps, and sewage pumping stations.

Made of aluminum machined for ½" pipe thread mounting, they are furnished with compressible Neoprene packing to support either one or two wire suspension electrodes.

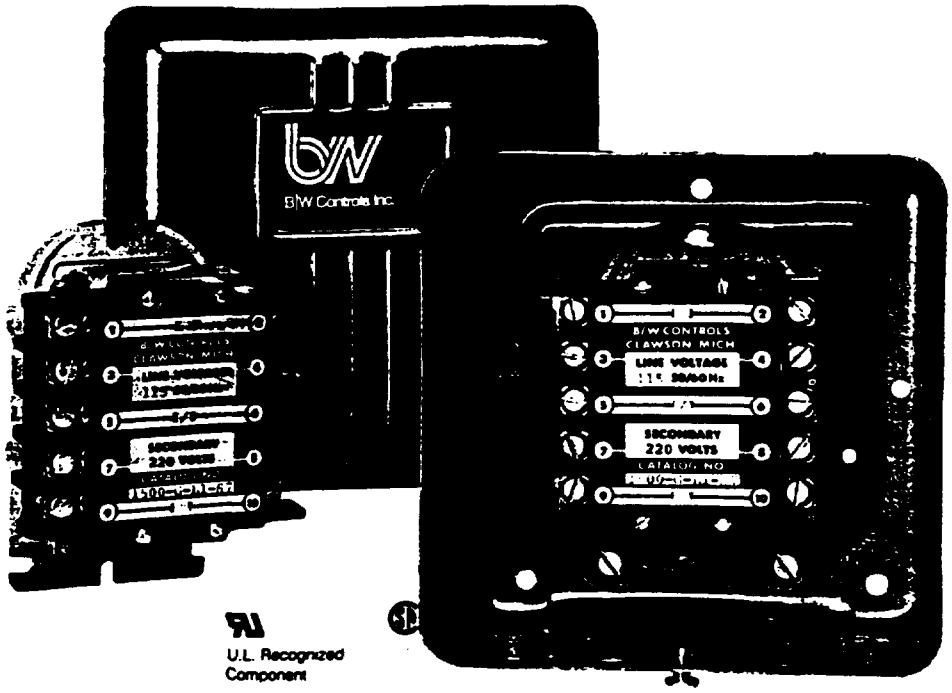
Type CG2 with E-IS Electrodes

CATALOG NUMBER 6012 ——— CG1

	No. of Electrodes	Holder Material	Mounting Thread	Old Part Number	LIST PRICE
CG1	1	Aluminum	½" NPT	12-055900	$12.00
CG2	2	Aluminum	½" NPT	12-056000	12.00

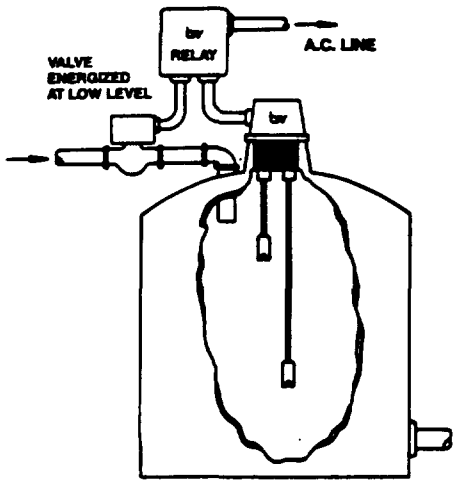
NOTE: The required wire suspension electrodes must be ordered as separate items. See Catalog Section 6013, page 12 for ordering information.

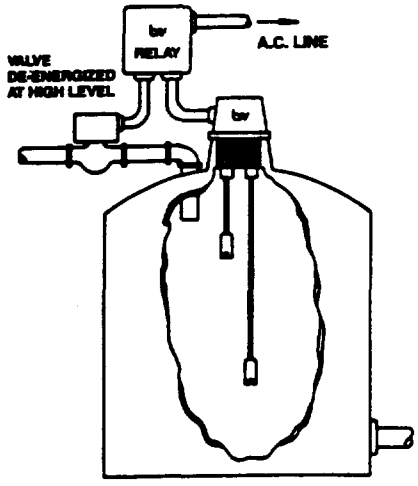
THE ALL NEW B|W 1500 SERIES INDUCTION RELAY *WITH FIELD CONVERTIBLE CONTACTS* PROVIDES A VERSATILE AND RELIABLE LIQUID LEVEL CONTROL



U.L. Recognized Component

TYPICAL LEVEL CONTROL SYSTEM USING THE B|W 1500-D RELAY TO ACTUATE A SOLENOID VALVE IN THE SUPPLY LINE.





FEATURES:

- **Available with 1, 2, or 3 isolated, double break contacts**
- **Nine different contact arrangements to meet a broad range of applications**
- **Contact arrangement can be added *and/or* changed in the field from N.O. to N.C. or N.C. to N.O.**
- **All contacts rated at 25 AMP, 1HP at 120V or 240 VAC**

MagneTek Controls
B/W Controls

1060 N. Crooks Rd., Clawson, Michigan 48017-1097
Phone: 313 435 0700 EasyLink: 628 32092
Fax: 313 280 1544 Telex: 23 5359

January 1985

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO.	SS1-X4
NAME	EXTRACTION WELL FLOW INDICATORS
LOCATION	EXTRACTION WELLS
MANUFACTURER	Badger Meter Inc.
DISTRIBUTOR	
DESCRIPTION	Badger Inc. flow indicator, Model OP, 1/2" Ø, bronze body, Kynar piston, flanged ends, range 1-6 gpm, equipped with: Model PFT-420 flow transmitter; remote reading Model ER-7R single indicator for flow rate (to be installed at extraction well); remote reading model ER-7R single indicator for totalization (to be installed at treatment plant)
MAINTENANCE	
COMPONENT PARTS	
SPARE PARTS	

Model OP Chemical and Sanitary

Industrial Oscillating Piston Meter

Technical Brief

GENERAL

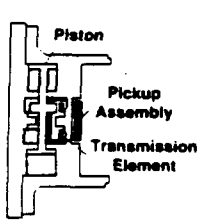
Badger's positive displacement meters, model OP are one of the most cost effective methods for metering process fluids in the chemical, pharmaceutical and food industries. The simple but efficient design of the OP meter generates high accuracy and repeatability over the entire meter flow range. Magnetic, "through the wall" transmission, prevents operator exposure to corrosive fluids and protects the fluid from external contamination.

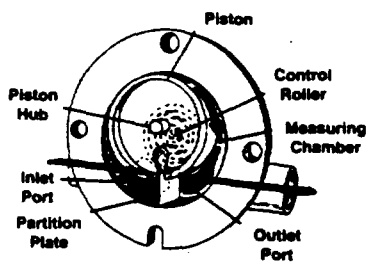
Offered in three sizes, 1/2", 1" and 2", for flows up to 100 GPM, these meters are extremely rugged, reliable and need little maintenance and calibration. With only three internal moving parts, maintenance is seldom required. If necessary, it takes but a few minutes. All parts are designed and built of materials recommended for your application, providing you with a long life, trouble-free, precision flow meter. All sizes of the meter are offered in chemical and sanitary, 3A approved, configurations with a wide variety of end fittings to match your piping. Their compact design and mode of operation allows for installation in tight spaces and in any position.

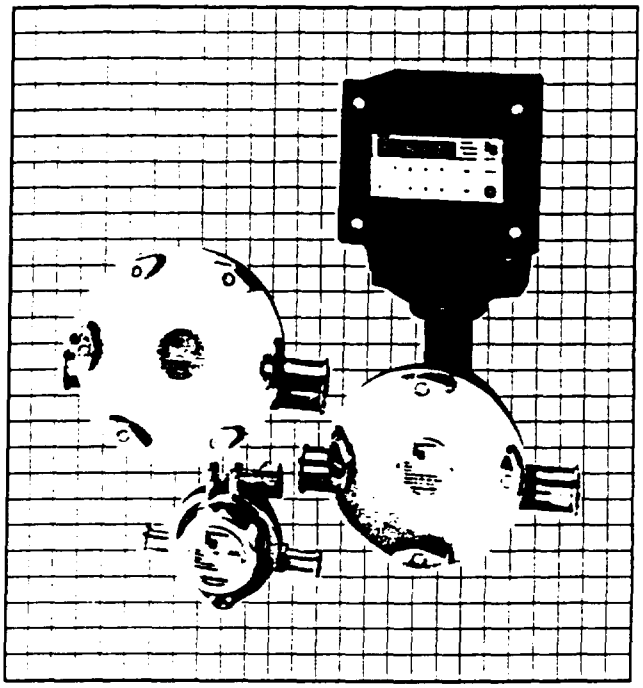
To complement the OP meter line, Badger offers a complete line of accessories that includes mechanical, pneumatic, electromechanical and electronic transmitters, totalizers, indicators and batch/process controllers.

OPERATION

The meter function is based on the continuous filling and discharging of the measuring chamber (positive displacement). Controlled clearances between the piston and the chamber insure minimum gap leakage for precise measurement of each volume cycle. As the piston oscillates, its' center hub rotates a magnet, whose movement is sensed through the meter wall by electromagnetic sensors or by a follower magnet. Each revolution of the magnet is equivalent to a fixed volume of fluid, which is converted to any engineering unit of measure for totalization, indication or process control.





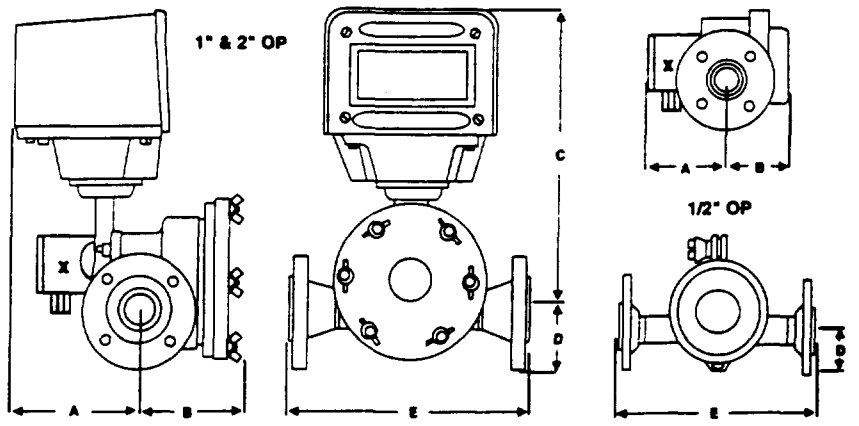


MATERIALS OF CONSTRUCTION

	1/2"	1"	2"
BODY MATERIALS:			
316 SS (raised face flanges)	x	x	x
Brass (flat face flanges)		x	x
PISTON MATERIALS:			
Polypropelene (hi or low temp.)		x	x
Kynar (hi or low temp.)	x	x	x
Ryton (one temp.)	x	x	x
Carbon (one temp.)		x	x
Kel-F (hi or low temp.)		x	x
"O" RING MATERIALS:			
Buna N	x	x	x
EPR	x	x	x
Viton	x	x	x
Teflon	x	x	x
NPR	x	x	x
Butyl	x	x	x
BUSHING MATERIAL:	Rulon		
MAGNET CASING:	Alloy 20		
CONTROL ROLLER:	Alloy 20		

Badger Meter, Inc.
Industrial Division

Bulletin No. ITB-050-06
April 1992



	1/2"	1"	2"
A	4.31"	6.16"	6.63"
B	2.32"	3.81"	5.56"
C		15.83"	16.21"
D	1.75"	2.87"	3.00"
E	6.75"	11.00"	12.62"
E*	6.75"	11.00"	11.81"
E**	6.75"	11.00"	12.13"

* Tri-Clamp/Cherry Burrel
** IMDA

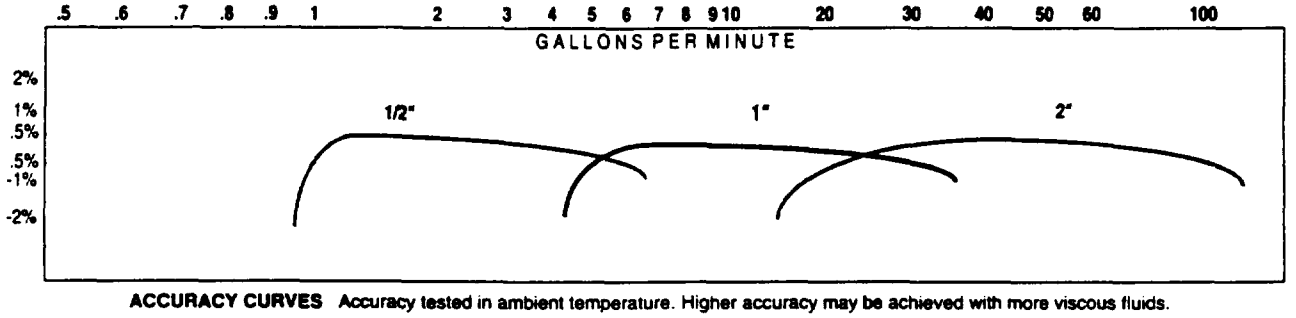
Dimensions shown are of meter with angle drive and PC meter mount or with rear drive and transmitter.

Dimensions for other system configurations may vary slightly. Please consult with factory

OPERATING & PERFORMANCE SPECIFICATIONS

	1/2"	1"	2"
• **Minimum Flow Rate, Q Minimum:**	1 gpm	5 gpm	20 gpm
• **Continuous Operating Maximum Rate:**	4 gpm	20 gpm	65 gpm
• **Short Duration Maximum Flow, Q Maximum:**	6 gpm	30 gpm	100 gpm
Continuous operation is acceptable at these rates but accelerated wear of the piston and/or bushings may occur.			
• **Standard Flange Connections*, Chemical:**	150/300* psi ANSI 16.5	150 psi ANSI 16.5	150 psi ANSI 16.5
• **Standard Connections, Sanitary:**	Tri-Clamp	Tri-Clamp IMDA threaded Cherry Burrel I or Q	Tri-Clamp IMDA threaded Cherry Burrel I or Q
Sanitary OP meters have 3A approval. Polypropelene (1" & 2" only) or Kynar piston is required.			
* 1/2" Chemical meter can be ordered with 1" flanges for low flow applications on 1" lines. All sizes available with optional 300 psi flanges.			
• **Pressure Drop at Maximum Flow:** (@ viscosity & specific gravity of water)	1.7 psi	4 psi	8 psi
• **Maximum Viscosity Limit:**	Pressure loss increases with fluid viscosity 10,000 cps (flow range is decreased as viscosity increases)		
• **Maximum Operating Pressure:**	150 psi for 316SS - 100 psi for Brass		
• **Maximum Operating Temperature:**	250° F on high temp. pistons / 120° F on low temp. pistons		
• **Minimum Operating Temperature**:**	Limited by piston material, recommended 40° F		
**Minimum temperature for stated accuracy			
• **Accuracy :**	± 0.5% over entire meter flow range		
• **Repeatability:**	± 0.2% or better under similar repeatable batch operations		

Metric Conversion: psi x 0.0703 = BARS gpm x 3.785 = liters per minute °F - 32 x .555 = °C



ACCURACY CURVES Accuracy tested in ambient temperature. Higher accuracy may be achieved with more viscous fluids.

Badger Meter, Inc. Industrial Division
4545 W. Brown Deer Road, P. O. Box 23099 Milwaukee, WI 53223-0099
Telephone: (414) 355-0400 • Voice Mail: (414) 355-0410, Extension 637
Fax: (414) 355-7499 • Telex: WU 2-6757 – RCA 201313

Model FT-420 & PFT-420 (Two-Wire, 4-20 ma DC and Pulse) Flow Transmitter

Technical Brief

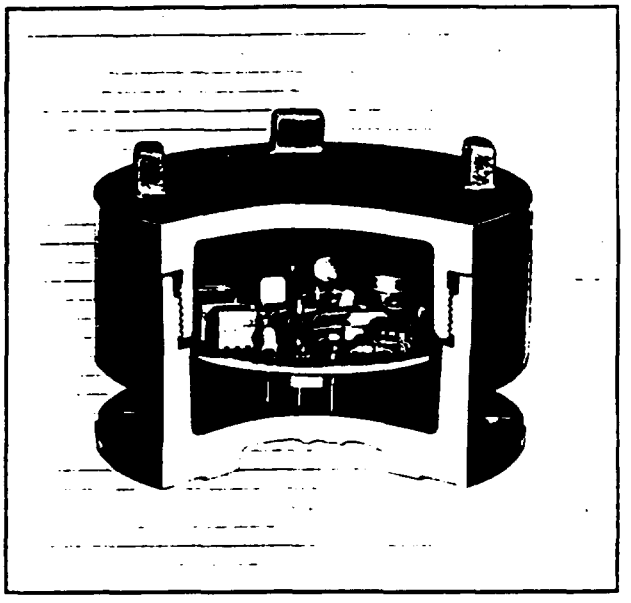
General

The model FT-420 & PFT-420 are versatile electronic flow transmitters for use with Badger's complete line of flow meters. These solid state units produce a 4-20 ma DC output signal through a two-wire design. They also provide a transistor switched pulse-rate signal.

The two-wire, 4-20 ma DC signal is directly proportional to the flow rate in the meter and is completely isolated, preventing the formation of ground loops. The signal has excellent linearity, accuracy and repeatability as well as being resistant to internal and external electric interference.

The isolated, pulse-rate signal is generated by an open collector transistor. It has a square wave format which provides positive pickup of the flow meter's pulse-rate.

By nature of the electronic pickup, the FT-420 & PFT-420 significantly reduce mechanical load on the flow meter extending, in most cases, the operational flow range and improving the accuracy of the meter.



Applications

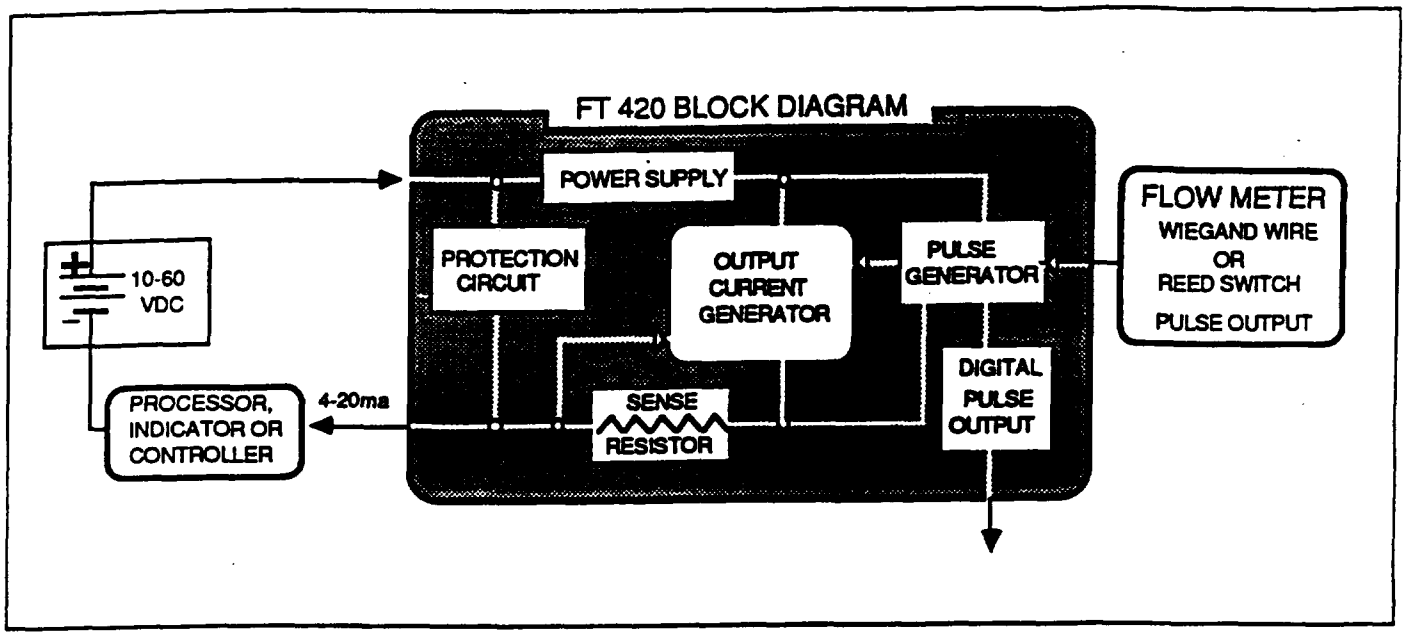
In general, these flow transmitters can precisely condition and transmit flow meter signals for process control in the chemical, food & beverage, water conditioning, pharmaceutical and any other industry where precise measurement and control of fluid flow is required. Twin outputs can be applied to:

- **Totalize and indicate flow**
- **Batch and regulate flow**
- **Provide signal to hi-low flow controllers**
- **Signal process computors**

Operation

The FT-420 & PFT-420 flow transmitters accept pulse signals generated by either a Wiegand wire / magnet or by a reed switch / magnet interaction in the flow meter. The pulse input is then decoded and standardized by a pulse form network. A current regulator accepts the standard signals and converts the pulse rate into a steady current signal (4-20ma) directly proportional to the rate of flow of the fluid through the meter; 4 ma representing zero flow and 20 ma representing full flow (user can adjust span to suit application). Power for the device is derived from the 10-60 DC supply, 4 ma "zero" current. Each input pulse is also repeated on the isolated transistor switch in a square wave format. Two-wire connections are provided for each of the two signal outputs.

J•M INDUSTRIAL SUPPLY LIMITED
2899 Steeles Avenue West, Unit 4
Downsview, Ontario M3J 3A1
Tel. (416) 665-2300
Telex 06-217758



GENERAL SPECIFICATIONS

ENVIRONMENTAL

Operating Temperature: -20°F to 250°F
Humidity: 5% to 100% non-condensing
Enclosures: NEMA 4 & 4X

ELECTRICAL

Inputs
Supply Voltage: 10 to 60 VDC
Pulse Input:
Circuit Interface: Transformer isolated
Pulse magnitude: (0.5 to 5 VDC)
Pulse Polarity: Pos. or Neg. @ 200 Hz max.
Alternating pos/neg. pulse @ 100 Hz max.
Switch Closure: 40 to 60% duty cycle @ 100 Hz

Outputs
Digital
Opto-isolator: Open collector transistor
Max. Voltage: 40 VDC
Max. Current: 20 ma @ 0.5 VDC
Pulse Width: 1 millisecond (± 0.1 msec.)
Pulse Rate: Input rate X 2

Analog
Two-wire signal/power
Max. Voltage: 10 to 60 VDC supply
Current: 4 to 20 ma
Max. Load Resistance (ohms) = 50+[50x(VDC-10)]

PERFORMANCE

Analog Output
Two-wire (signal/power) circuit interface with reversed polaruty protection.

Accuracy: Within 0.5% of point (10:1 range)
Repeatability: Within 0.2% of point
Max. Ripple: 0.1 ma @ 10% of span calabration
Response: 3 sec. to within 95% of total change

Operatioinal Drift: Less than 10 microamps
Thermal Drift: Less than 1 microamp per ° C

O.V. Protection: 82 volt MOV, 2.5 watt-sec

Span Adjustment: 10 to 30 ma
Zero Adjustment: 3 to 12 ma
Zero Stability: 3.97 ma to 4.03 ma

REPRESENTATIVE:

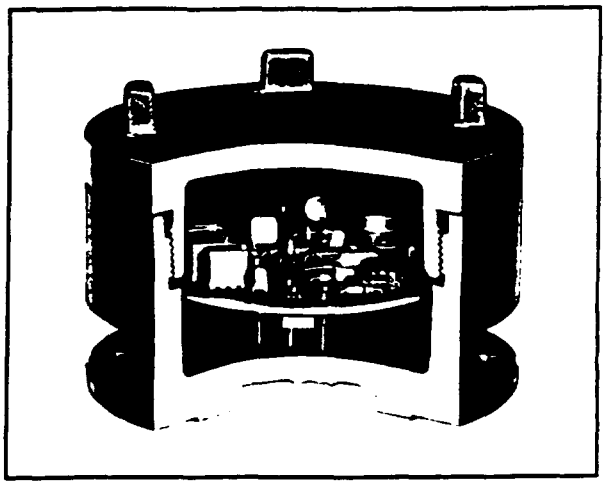
Models FT-420 & PFT-420 series

Digital and Analog Flow Transmitter

Installation & Operation Brief

Description

The series of FT 420 & PFT 420 flow transmitters are usually assembled and mounted to the flow meter. However, they can be retrofitted on top of an already installed meter, including all magnetically driven models of OP, Turbo, Disc and Propeller meters. They are housed in a bronze housing similar to the MSE5 & EPT1 (Model FT 420) transmitters, an aluminum housing similar to the MSE1 (Models FT 420 1& FT420 R) or a high impact resistant plastic housing (Models PFT 420, 420/1, 420/2 & 420/R) depending on the meter/ transmitter configuration. See Bulletin IRP-049-02. It can also be mounted inside the PC-100 meter mounted housing.



Operation

The FT 420 & PFT 420 series have both pulse and analog outputs. The pulse output is generated by an open collector transistor, and it is equivalent to the scaled (or unscaled) pulse rate received from the main pickup element or retransmitting pulser. The analog output is a two wire 4-20 ma signal proportional to flow rate. It is normally calibrated at the factory to produce 4 ma at zero flow and 20 ma at any flow up to the maximum flow rate of the meter. Special calibration can be done at the factory on request or it can easily be done in the field.

Mounting

The FT 420 or PFT 420 unit directly replaces the MS-E1 pulse transmitter on Turbo meters and the MS-E5 on OP, Disc and propeller meters. Depending on the PFT model selected, a simple plastic adapter may be required. For Turbo meters, it is necessary to replace the gear adapter with a Wiegand wire adapter and make sure that the rotor assembly in the meter contains a 4 pole instead of a 2 pole magnet. The transmitter can also be operated in a remote location (model FT 420/R & PFT 420/R). However, this can only be done with the following transmitters: FT1, FT2, PFT2 and MS series transmitters.

METER K FACTOR CHART

Meter Size	Meter Model	20 ma at GPM	Pulses per Gallon
5/8"	SC-ER Disc	20	320.00
3/4"	SC-ER Disc	30	265.76
1"	SC-ER Disc	50	86.88
1-1/2"	SC-ER Disc	100	38.16
2"	SC-ER Disc	160	20.08
1/2"	OP piston	5	445.92
1"	OP piston	30	153.28
2"	OP piston	100	41.12
2"	Turbo	160	34.72
3"	Turbo	350	24.80
4"	Turbo	1000	5.12
6"	Turbo	2000	2.16
4"	Propeller	450	12.16
6"	Propeller	1000	3.20
8"	Propeller	1200	1.79
10"	Propeller	1600	1.06
12"	Propeller	2250	0.74
14"	Propeller	3000	0.54

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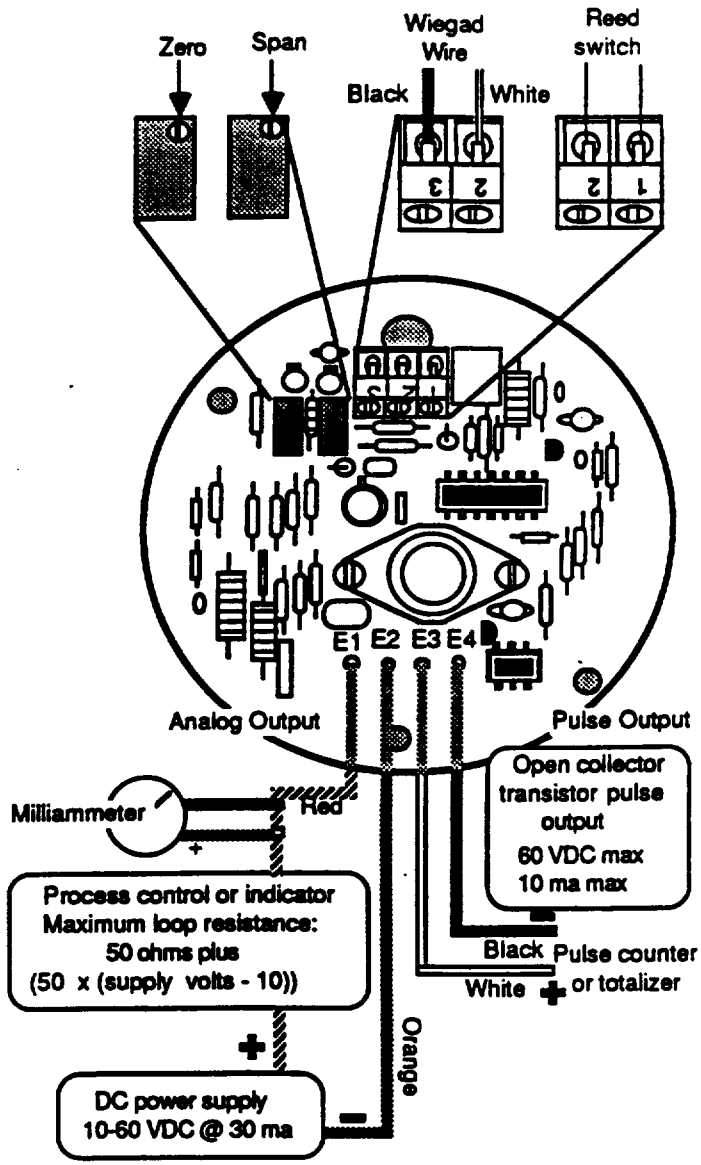
Telex 06-217758
201313

Calibration

The FT 420 & PFT 420 analog signal is calibrated at the factory, relative to the standard flow rate of the accompanying meter(i.e. 2" Turbo 4ma at no flow and 20ma at 160 GPM.) The customer can recalibrate the unit to suit his own application. To recalibrate the unit first remove the transmitter cover. Connect a milliammeter (VOM or Simpson) as shown.

- Connect a pulse counter on the pulse output and count the number of pulses received in one minute. (Refer to meter factor table, to determine flow rate).
- Increase your fluid flow to the rate at which 20 ma output is desired.
- Using a small screwdriver adjust SPAN pot clockwise to increase analog output and counterclockwise to decrease it.

Example: Pulse counter registers 1260 pulses per minute on a 2" Turbo meter. A 2" Turbo has a K factor of 18 pulses per gallon. Thus, 1260/18 =70 GPM. Customer requires 20 ma at 75 GPM. Therefore, he adjusts system to increase flow and obtain 1350 pulses per minute (75 x 18). Once this is done the SPAN pot can be adjusted to 20 ma using the milliammeter.



WIRING PROCEDURE

Signal Inputs:

The circuit board contains an input terminal block with three screw terminals. Use terminal #1 & #2 to connect the two wires from a reed switch pickup or transmitter such as the two wires coming up through the OP right angle drive or an MS series transmitter on a remote FT420/R. Use terminals #2 & #3 to connect the Wiegand wire pickup from a Turbo meter adapter.

Signal Outputs:

The transmitter board has four signal output wires. A black and a white for pulse output and a red and orange for the analog output.

-Analog Output:

Connect the RED wire to the positive terminal of the DC supply on the indicator or controller and the ORANGE wire to the negative terminal.

-Digital Output:

Connect the WHITE lead to the positive terminal of the counter or controller and the BLACK to the negative terminal.

WARRANTY

Badger warrants all meters and parts manufactured by it and supplied hereunder to be free from defects in materials and workmanship for 18 months from date of shipment or 12 months from date of installation whichever period shall be shorter. If within such period any meters or parts shall be proved to Seller's satisfaction to be defective, such meters or parts shall be repaired or replaced at Seller's option. Seller's obligation hereunder shall be limited to such repair and replacement and shall be conditioned upon Seller's receiving written notice of any alleged defect within 10 days after its discovery and, at the Seller's option, return of such meters or parts to Seller f.o.b. its factory.THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESSED OR IMPLIED WARRANTIES INCLUDED BUT NOT LIMITED TO IMPLIED WARRANTIES (EXCEPT FOR TITLE) OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE. Badger shall not be liable for any defects attributable to acts or omissions of others after shipment, nor any consequential, incidental or contingent damage whatsoever.

Model ER-7 & ER-7/R (Remote) Digital Resettable Totalizer or Digital Rate of Flow Indicator

Technical Brief

GENERAL

Badger's Model ER-7 register is a meter mounted totalizer/rate indicator designed for use with Badger's HPV™ series of flow meters. The ER-7/R is the remote version and can be used with any Badger flow meter when equipped with compatible unscaled pulse transmitters. A rear adapter plate is provided with the remote version for attachment to a wall or other suitable surface. The ER-7 series registers are available with one or two indicators. Either indicator can be programmed as a rate-of-flow indicator or as a resettable totalizer. If you require simultaneous display of rate-of-flow and totalization, you must order the register with two indicators.

The registers are battery powered. They get their input pulses from the proximity sensor located within the HPV meter or from the meter pulse transmitter, if you are using the remote version. Proximity sensors and other electronic sensors with open collector outputs must be externally powered.

DESCRIPTION

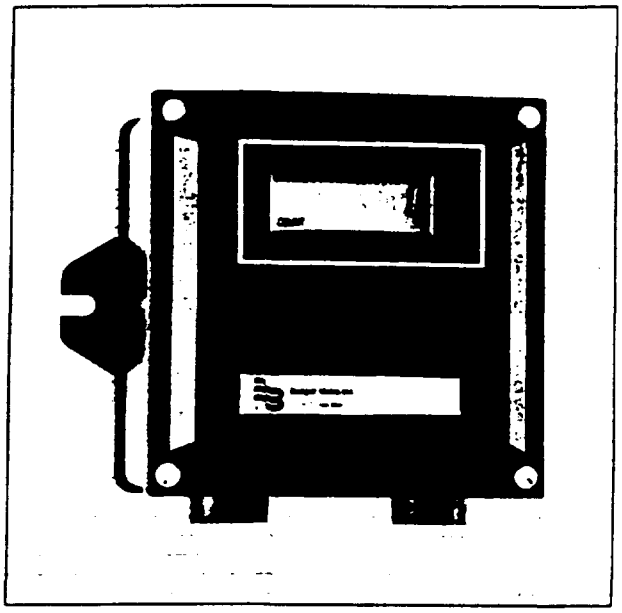
The indicators utilize the latest LSI technology. They have crisp, 8 digit numeric LCD displays. Step by step programming is similar to programming a digital watch, and can be done from the front panel. Upon completion of the procedure, reprogramming can be inhibited by repositioning a jumper located on the rear of the unit.

When the indicator is programmed as a totalizer, the display can be reset to zero from the front panel switch or from an external switch wired directly to the rear connector. The front panel reset button can be inhibited by repositioning a rear jumper.

A programmable pre-counter allows you to indicate in any engineering unit of measure. (Gallons, pints, pounds, etc.) You can read to the nearest 0.1 or 0.01 unit depending on the type and size of the flow meter.

Operation

Fluid flowing through the meter causes pulses to be generated by the sensor or transmitter. Each pulse represents a specific volume of fluid. Using the 1" HPV meter as an example, 444 pulses are generated every time one gallon of fluid passes through the meter. If you program the pre-counter for 0444, the least significant digit on the display will increment once every time the register counts 444 pulses. You would be able to measure to the nearest gallon.



ER-7-R with rear adapter plate

Features

- All Solid State Components For Long Life
- Displays Are Battery Powered For Memory Retention
- Corrosion Resistant Plastic Housing Built To NEMA 4X Specifications
- Programmable For Rate of Flow or Totalization
- Programmable Pre-Counter
- Front Panel Totalizer Reset Switch Can Be Disabled
- Front Panel Programming Can Be Inhibited

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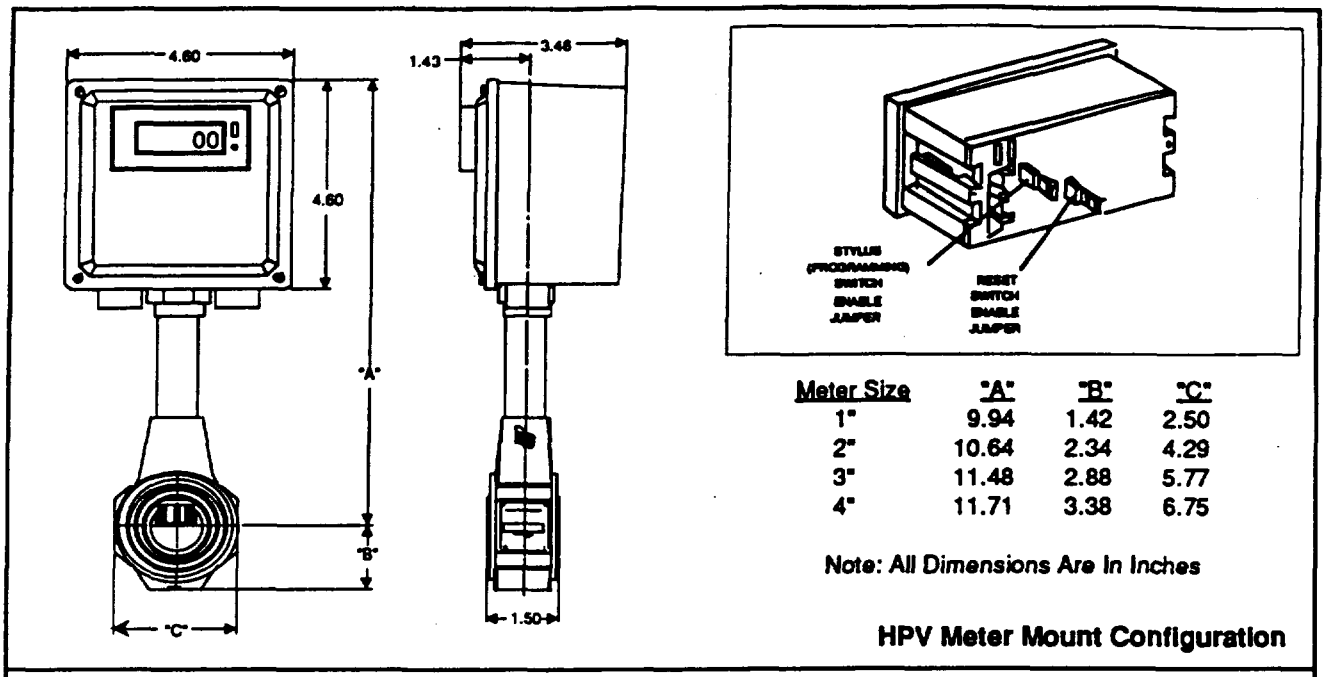
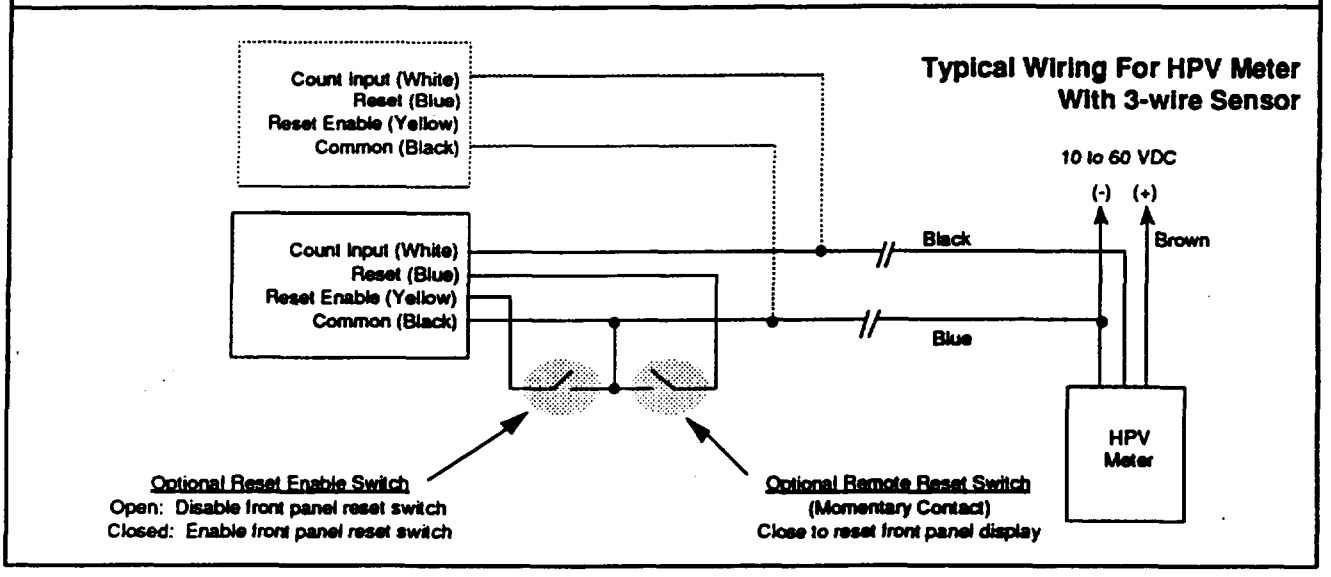


Meter Size	"A"	"B"	"C"
1"	9.94	1.42	2.50
2"	10.64	2.34	4.29
3"	11.48	2.88	5.77
4"	11.71	3.38	6.75

Note: All Dimensions Are In Inches

HPV Meter Mount Configuration



Typical Wiring For HPV Meter With 3-wire Sensor

ER-7 & ER-7/R SPECIFICATIONS

POWER SOURCE:
Indicators: 3 volt Lithium battery lasting up to 8 years.

DISPLAY: Eight digit LCD with .35" high characters

OPERATING TEMP:
Indicator: 32° F to 167° F

ACCURACY: ±.01%, ±1 DIGIT for RATE

INPUTS: Low speed (reed Switch) input can operate up to 25 counts per second.

High Speed (electronic sensors) input can operate up to 5000 counts per second when driven with a 50% duty cycle.

TYPES: TTL, CMOS, open collector sink, relay contact to common, magnetic pickups having > 2.0 VOLTS peak output into 10KΩ load or any signal source that can supply the following DC voltages:
Input HIGH is > 2.0 volts.
Input LOW is < 1.0 volt.
Maximum input voltage is ± 28 volts.

REMOTE RESET: Forces reset when pulled below 1.0 v.

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-V1

NAME EXTRACTION WELL FLOW CONTROL BALL VALVES

LOCATION EXTRACTION WELLS

MANUFACTURER Worcester

DISTRIBUTOR

DESCRIPTION Flow control ball valve, 1/2" Ø Worcester #CPT 4466PMS EG60, all stainless steel, screwed ends 60 Deg. equipped with: Worcester #1075-5W 120 VAC Electric Actuator, NEMA IV Housing, 100% Duty Cycle Motor; #HO99 set point controller designed to accept 4-20MA signal from flow indicator; #MKOOG S/6 mounting kit to couple valve and actuator

MAINTENANCE

COMPONENT PARTS

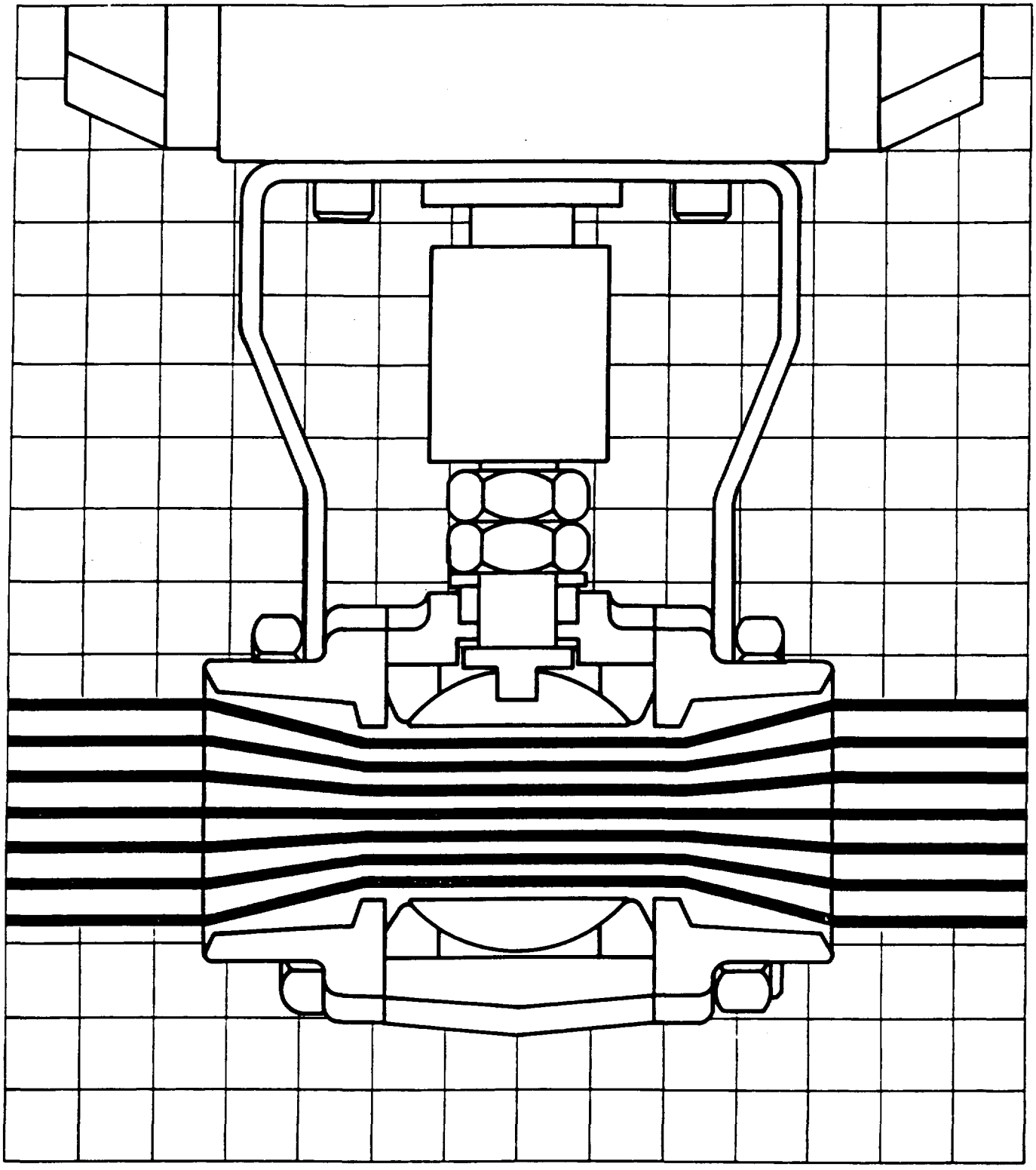
SPARE PARTS

Worcester Controls
A BTR Company

Series 44 Ball Valves

3-piece ball valves that meet all requirements for material compatibility, shutoff, end connections and safety.

PB-401-26



How To Order

1 1/2"	4	6	6	T	SW

VALVE SIZE	PRODUCT SERIES	BODY, PIPE ENDS	BALL, STEM	SEAT	BODY SEAL	ENDS
1/4" 3/8" 1/2" 3/4" 1" 1 1/4" 1 1/2" 2"	4	1-Brass 4-Carbon Steel 6-316 S.S. A-Alloy 20	1-Brass* 4-Carbon Steel* 6-316 S.S. 7-Monel A-Alloy 20® C-Hastelloy C	B-Buna N-Neoprene T-TFE R-Reinforced TFE Y-Lubetal™ P-Polyfill® U-UHMWPE *Use only one letter if body seal is to be same material as seat.*	B-Buna N-Neoprene T-TFE E-EPR V-Viton® M-TFE Coated 316 S.S. U-UHMWPE	SE-**Screwed Pipe Ends** (NPT), Any Sch. Pipe† Carbon Steel Stainless Steel Brass Alloy 20 **Butt Weld Ends** BW1-Stainless Steel, Sch. 10 BW4-Carbon Steel, Sch. 40 BW5-Stainless Steel, Sch. 5 TE-**Solder/Sweat Ends** Brass-Type K, L, or M copper tube SW-**Socket Weld Ends,** Any Sch. Pipe† Carbon Steel Stainless Steel Alloy 20 SWO-**Socket Weld Ends, O.D. Tube** Stainless Steel (not available in 1/4" and 3/8" sizes)

* Carbon Steel and Brass ball are hard chrome plated

Example: 1 1/2" Series 44 with 316 s.s. body ball and stem, TFE seats and seals, and socket weld ends.

†All IPS schedules of aluminum, stainless, carbon and alloy steel pipe, S.P.S. copper pipe and red brass pipe.

®Viton is a registered trademark of E.I. duPont.
™Lubetal is a trademark of Garlock.
®Polyfill is a registered trademark of Worcester Controls
®Alloy 20 is a registered trademark of Carpenter Technology

Externals: Externals, including handles, are normally constructed of zinc plated carbon steel. Handles are vinyl coated. When required, the body bolts, nuts, follower, adjusting nut and handle nut are also available in stainless steel by special order, and come standard when ordering a 466 valve. Handle and stop plate are also standard in stainless steel when ordering a 4AA, or are available on special order with other combinations.

To order a Series 44 for use with:

34 or 36 actuators, prefix ordering code with "A". EXAMPLE: 1" A 446 PMSE
39 or 75 actuators, prefix ordering code with "B".

For additional information refer to

- **C-12 Corrosion Data** — For body, ball, stem and seat/seal material to media compatibility.
- **ASM Actuator Sizing Manual** — For seat material pressure/torque curves and actuator torque output charts.
- **PB 730 Series 75 Electric Actuators** — For detailed technical information.
- **PB 302 Series 39 Pneumatic Actuator** — For detailed technical information.
- **CV Ball Control Valve Brochure** — For standard ball control valves

Caution: Ball valves can retain pressurized media in the body cavity when closed. Use care when disassembling. Always open valve to relieve pressure prior to disassembly.

Due to continuous development of our product range, we reserve the right to alter the dimensions and information contained in this leaflet as required.

Distributed By:

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A BTR Company

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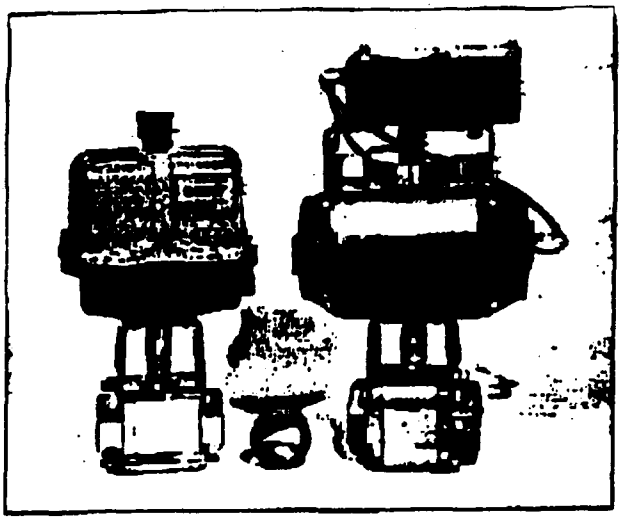
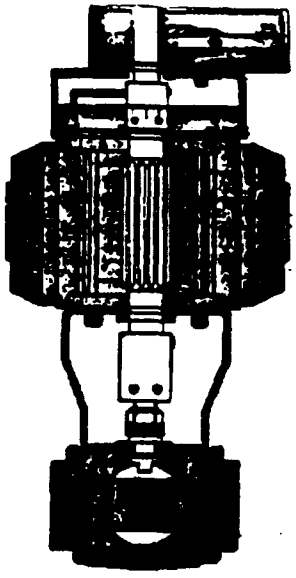




AUTOMATION PNEUMATIC AND ELECTRIC CONTROLS

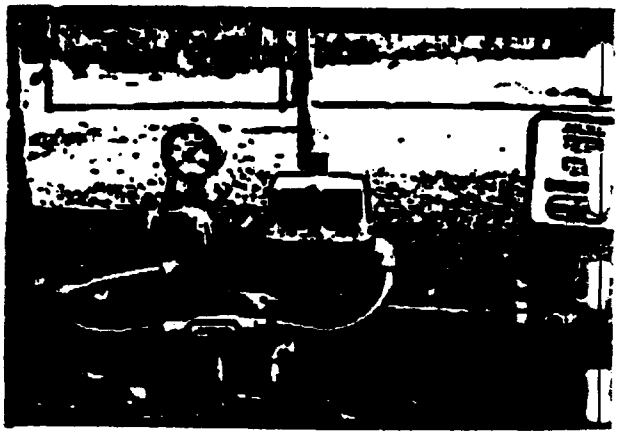
Easy automation is assured by our Series 39 pneumatic or Series 75 electric actuators. ***Both are backed by our exclusive two-year warranty.*** The Series 39 actuator is the toughest and most versatile rotary actuator available. Positioners (including electro-pneumatic) fail-safe feature, and mechanical and proximity limit switches provide ON/OFF or proportional control to your system with the feedback you require. Refer to Bulletin No. PB302.

Mount a Series 75 electric actuator and you have a high performance control valve package specifically designed for computer or PLC control. For proportional control, the *Series 75 can work with digital or analog control loops.* A variety of options allows you to select the performance criteria and feedback information you desire. The Series 75 is available with NEMA I, IV, VII or IX enclosures. Refer to Bulletin No. PB730.

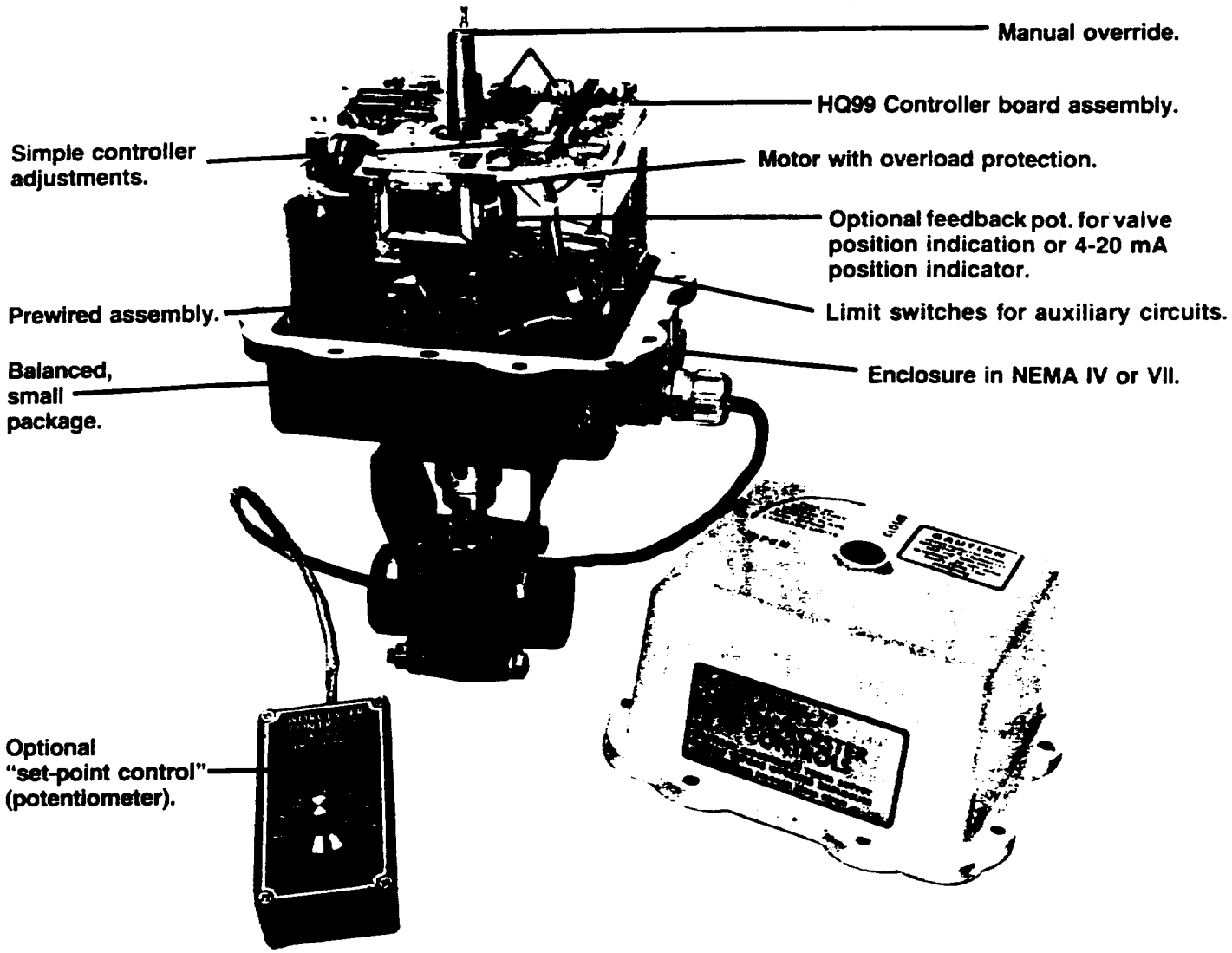
Worcester valves represent a profound improvement over traditional globe and rotary valves that use heavy linear actuators, crank arms and associated linkage. ***Worcester has eliminated significant hysteresis and assured repeatability by powering through a solidly clamped, in-line stem. All shafts operate together; actuator, positioner, valve stem. The design also eliminates side load on the valve stem because components (valve, actuator, positioner) are mounted symmetrically and weights are balanced. This extends valve stem seal life far beyond conventional valves.***

APPLICATIONS

- Steam Control
- Pressure Control
- Flow Control
- Temperature Control
- Level Control
- PH Control
- Low Flow Control
- High Abrasion Fluids
- Heat Transfer Fluids
- Slurry Control
- Paper Stock
- Water Flooding
- Oxygenation
- Food, Chemicals, Petroleum



The HQ99 Controller
Compact, reliable control for a variety of applications.



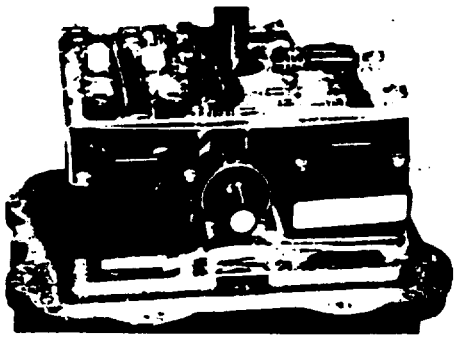
The new HQ99 solid state, electronic controller adds a new dimension to streamlining single loop process control. It is a cost effective solution to on-site control where there is no central control room for instruments and allows the set-point adjustment to be located where most convenient

Unique to the market, the HQ99 is a rugged, sensitive controller which when combined with an electric actuator, provides complete control function. The circuit board mounts inside the housing of the Worcester Controls Series 75 Electric Actuator and does not require its own special housing. The unit is protected by the actuators' NEMA IV and VII rated enclosures. Because the HQ99 is inside the control valve actuator, excess wiring is saved as well as the cost of a separate controller housing and the positioner function is eliminated, thus creating a simplified control loop.

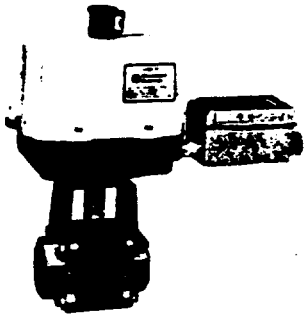
The HQ99, in conjunction with an internally or externally mounted set-point potentiometer unit, can regulate temperature, pressure, level, flow or any other process variable whose status can be transmitted via a variety of electric signals (see specifications). Solid state circuitry insures reliable, efficient service with energy savings.

The Series 75 Electric Actuator offers operational dependability and rugged compact design. It is available in six sizes offering torque outputs from 150-3000 in. lbs. A variety of NEMA enclosures and other electrical and mechanical options fit this actuator to the application. The HQ99 is optional equipment for the Series 75. A dual or single feedback potentiometer for remote position indication and limit switches for auxiliary circuitry are also available as options. Whether it is a hazardous, remote or difficult service, Worcester Controls can provide you with the process package you need for complete, accurate control.

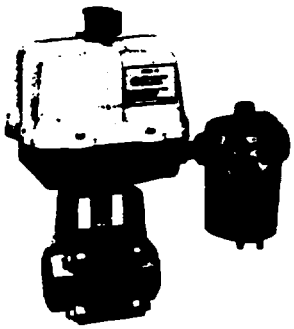
Principle of Operation



Internal Set Point Control

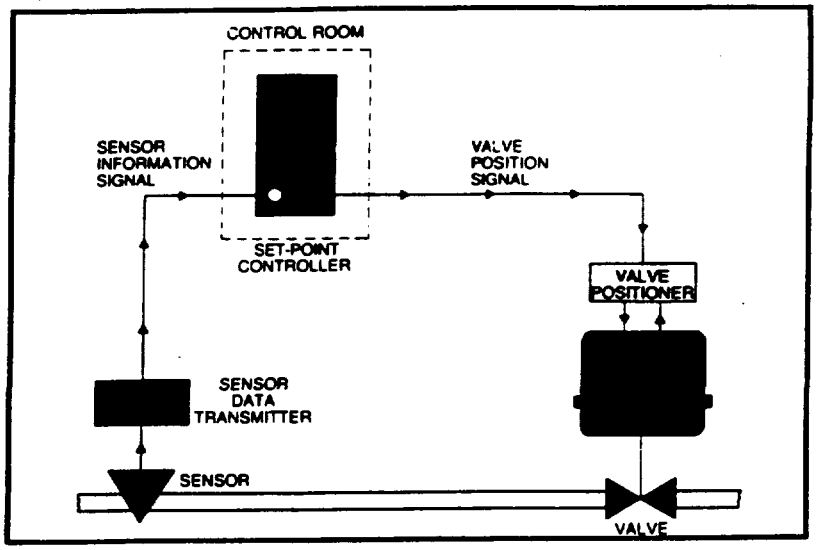


NEMA IV Externally Mounted Set Point Control

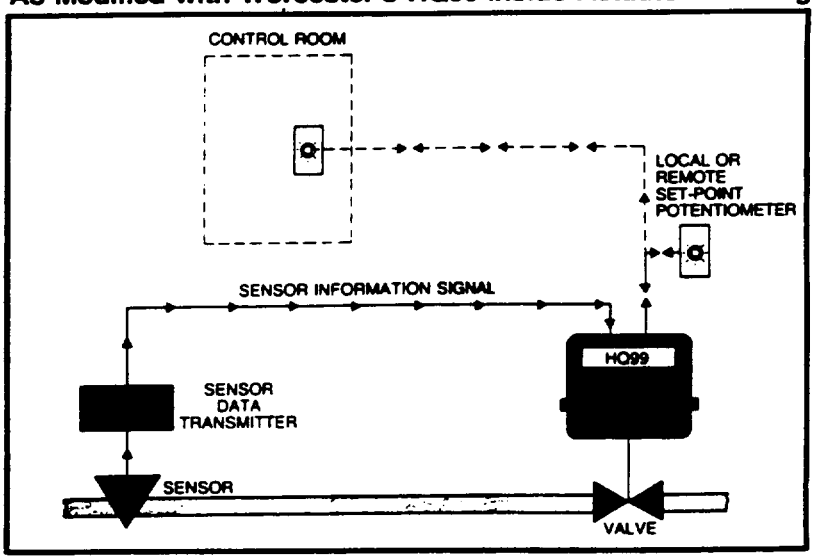


NEMA VII Externally Mounted Set Point Control

Typical Individual Process Control Loop



As Modified with Worcester's HQ99 Inside Actuator Housing



Control Loop Configuration

These two schematics illustrate the difference in process control loop configuration with and without Worcester's HQ99 Controller. The first schematic illustrates a typical process control loop. The signal from the sensor must pass through the set-point controller in the control room and the valve positioner before it finally reaches the valve and actuator package and affects valve position.

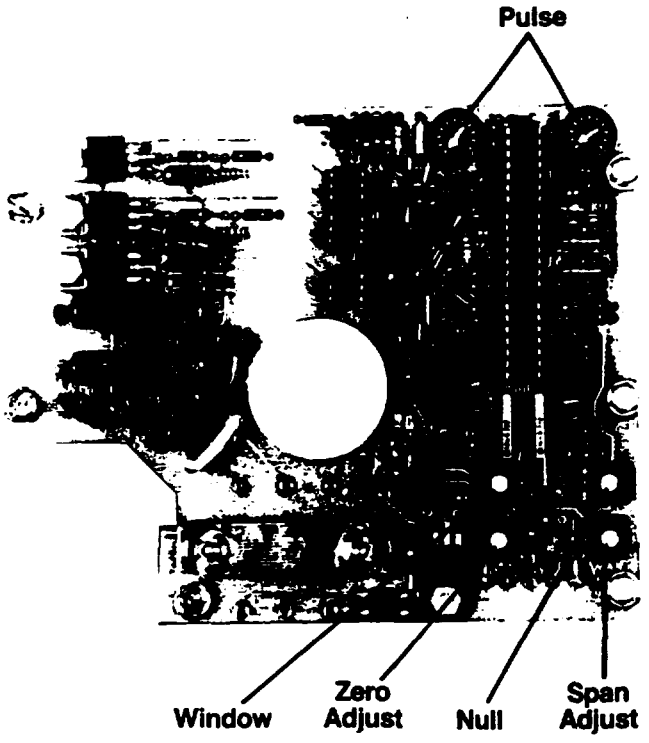
The second illustration shows the loop configuration simplicity gained by using an HQ99 Controller inside the actuator housing. The sensor signal follows a direct path to the HQ99, and the control loop is streamlined due to the combining of controller and positioner functions. The HQ99 Controller is completely protected inside the actuator's NEMA rated housing, and the set-point potentiometer may be located remotely or at the valve, or both, with a bypass switch for remote or local operation.

How it Works

The electric signal from the sensor (measuring element) is fed directly into the HQ99. The HQ99 reads this input signal, and compares it to the desired set-point of the process, which is controlled by a remote or local potentiometer. A set of limit points, one above and one below the set-point, define an electronic "window" for the HQ99. As long as the process variable's difference from the set-point falls within this window, the HQ99 will send electronic pulses to the actuator to correct the valve's position. If the deviance from the set-point falls outside the window, the HQ99 sends a continuous signal to the actuator, which will move the valve at a faster speed until the error falls within the window. At that point the HQ99 signal changes back to pulse mode until the set-point requirement is satisfied.

After the valve has completed its movement as instructed, the HQ99 observes a waiting period during which it compares the process variable's status to the set-point and makes sure no further movement is needed. This fast-slow-wait action allows quick yet stable response to process requirements.

HQ99 Adjustable Control



The HQ99 has several basic adjustable controls that allow flexibility in operation:

Zero Adjust:
Adjusts the HQ99 to match the minimum value of the sensor data transmitter's signal.

Span Adjust:
Adjusts the HQ99 to match the maximum value of the sensor data transmitter's signal.

Null:
Allows the increase or decrease of deadband about the set-point to inhibit spontaneous action of the controller by electrical noise.

Control Action Adjustment

These two controls adjust the manner in which the HQ99 responds to a change in signal.

Pulse Control:
A two-part control, which adjusts the on-time and off-time of the unit in the pulsing mode. This adjusts the effective speed of the unit while it is operating inside the "window." Both on and off times can be adjusted to fine tune the unit to match system requirements.

Window Control:
A control which adjusts the width of the "window." The window defines limits around the set-point at which the unit changes from slow to fast action. Outside the window, response is fast. The smaller the window, the faster the response. The larger the window, the more stable the unit.

Specifications

Input Signals:	Set-point 1K Pot. For others, consult factory	Sensor 4-20 mA 1-5 mA 10-5 mA 135 Ohms 1K Ohms
Operating Voltage:	120 VAC	
Independent Linearity:	0.5% of span	
Resolution:	0.5% of span	
Deadband:	0.4% of span	
Hysteresis:	0.5% of span	
Temperature:	-40°F (with heater and thermostat) to 115°F	
Set Point Potentiometer:	Standard Set Point Pot. (1K) Mounted inside the actuator at the factory.	
Duty Cycle:	Specify 75% or 100% duty cycle for actuator	

Power Consumption:	8 watts plus actuator power requirements
Characteristic:	Linear
Options:	Feedback potentiometer position indicator, 4-20 mA (single or dual) NEMA VII or IV external box for set point potentiometer.
Ordering Instructions: • Actuator Size • Power Supply •Set Point Location Internal External Optional NEMA IV external housing Optional NEMA VII external housing	When ordering, specify: • Sensor Signal • Standard Set Point Potentiometer (1K) or other (specify requirements)

Due to continuous development of our product range, we reserve the right to alter the dimensions and information contained in this leaflet as required.

Worcester Controls
A BTR Company

P.O. BOX 538, 33 LOCKE DRIVE
MARLBOROUGH, MA 01752
U.S.A.
(508) 481-4800 TELEX 6817563
FAX (508) 481-4454

20 MID-DOMINION ACRES
SCARBOROUGH, ONTARIO CANADA
M1S 4A5
(416) 298-1671 TELEX 065-25135
TELEFAX (416) 298-8330

Distributed by:

Printed in U.S.A. 3/90 10M WR

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-V3

NAME EXTRACTION WELL SAMPLING VALVES

LOCATION EXTRACTION WELLS

MANUFACTURER

DISTRIBUTOR

DESCRIPTION 1-inch/ 1/2-inch tee fitting with 1/2-inch sampling ball valve

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X2

NAME EXTRACTION WELL UNIONS

LOCATION EXTRACTION WELLS

MANUFACTURER

DISTRIBUTOR

DESCRIPTION 1-inch diameter, steel

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X5

NAME EXTRACTION WELL CHAMBER COVERS

LOCATION EXTRACTION WELLS

MANUFACTURER Bilco

DISTRIBUTOR

DESCRIPTION Bilco Pit Door, Size 2'-6" x 3'-0", Model O-3, lockable

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

EQUIPMENT SPECIFICATION FORM

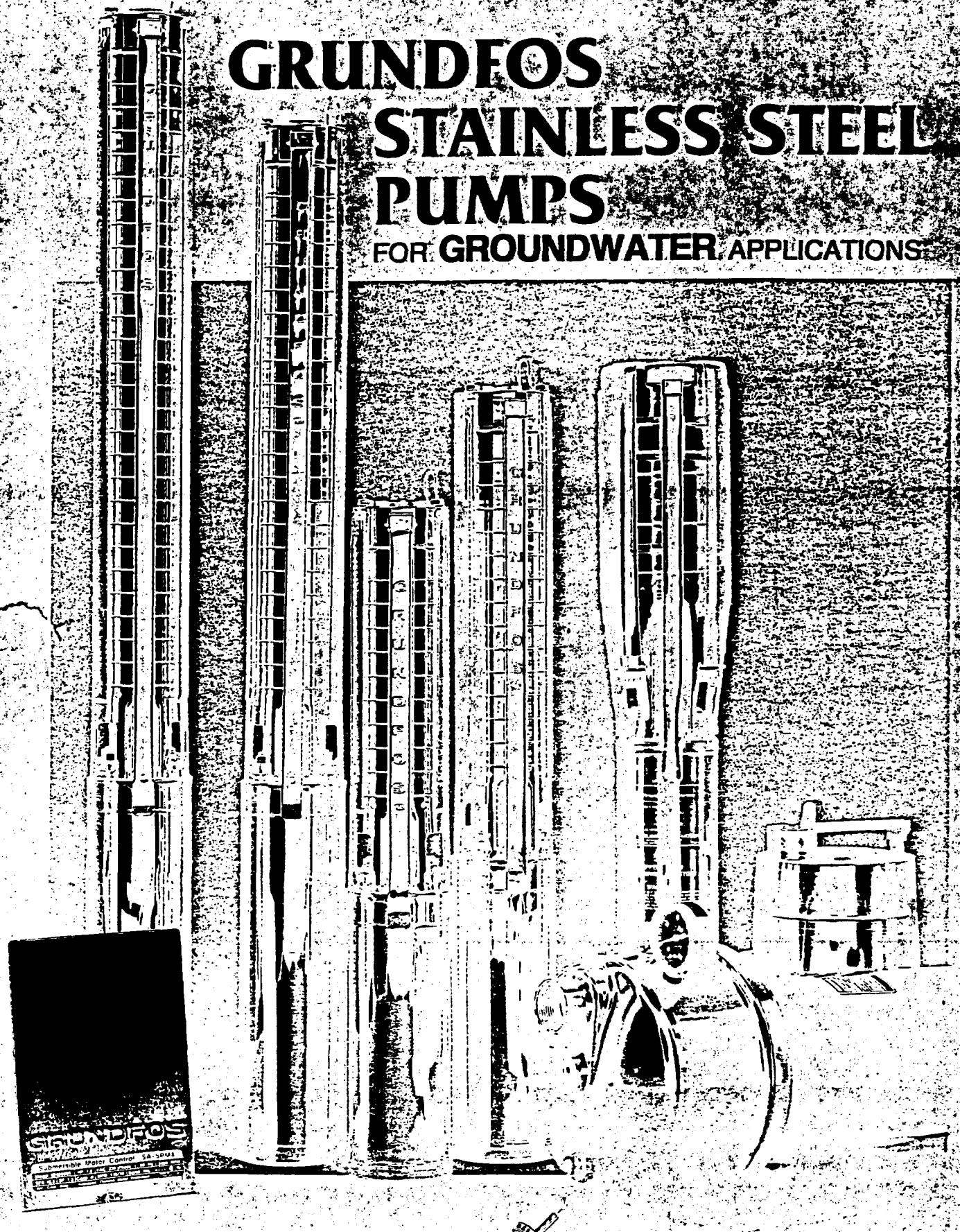
SUMMIT NATIONAL SITE

EQUIPMENT NO.	SS1-P2
NAME	WET WELL SUBMERSIBLE PUMPS
LOCATION	WET WELL
MANUFACTURER	Grundfos Pump Corporation
DISTRIBUTOR	Central Pump Dayton, Ohio 513-890-1206
DESCRIPTION	Model 60S20 - 4; 2 HP; 3 Phase; 460 volts; built-in check valve
MAINTENANCE	
COMPONENT PARTS	
SPARE PARTS	

GROUNDWATER CATALOG

GRUNDFOS STAINLESS STEEL PUMPS

FOR GROUNDWATER APPLICATIONS

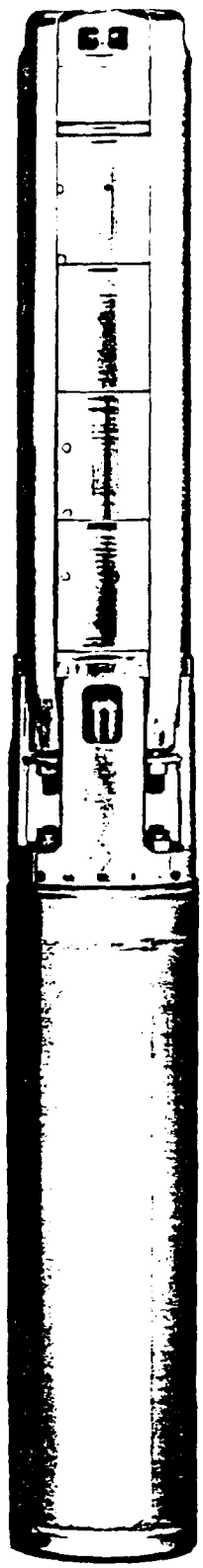


GRUNDFOS

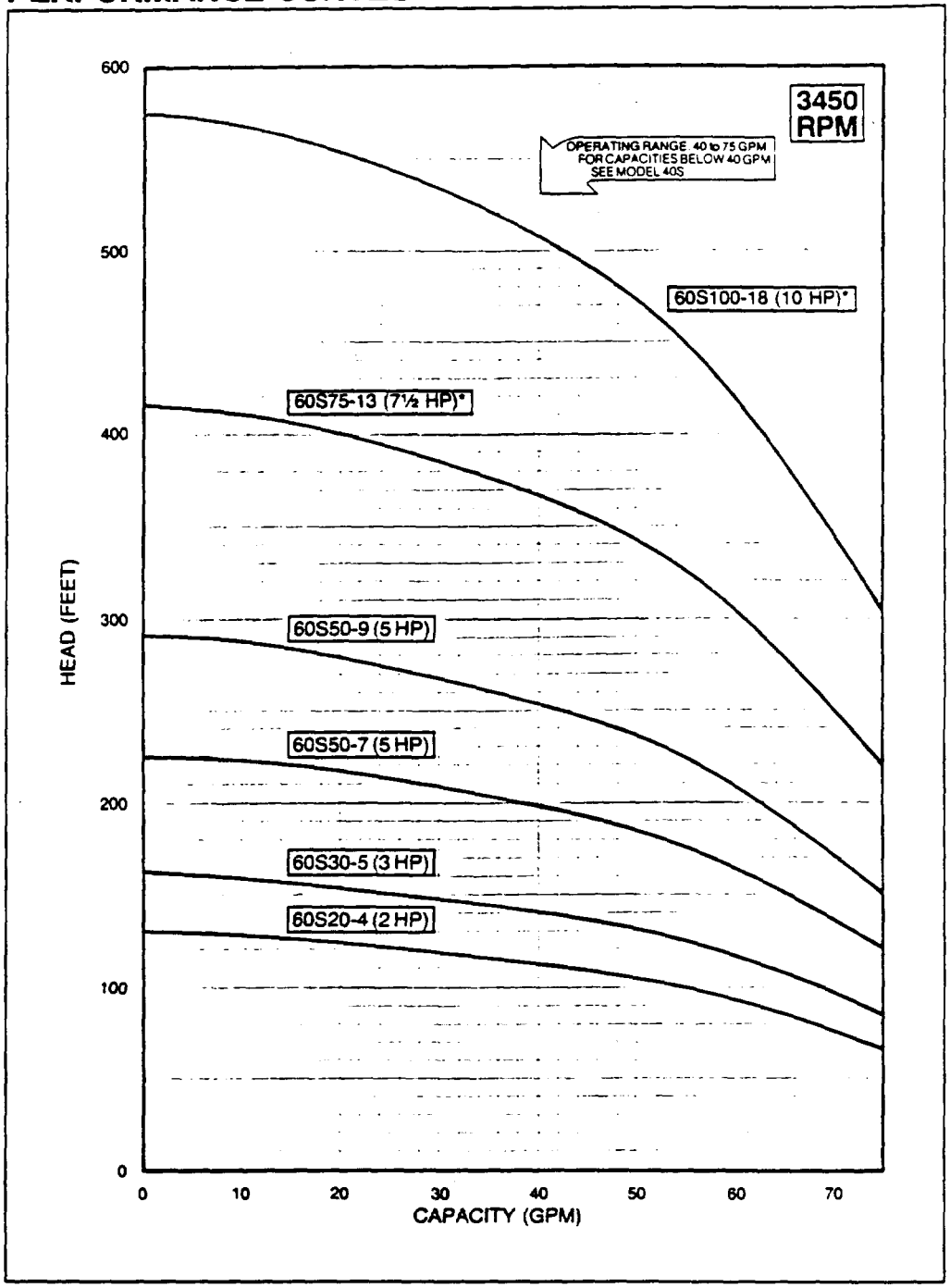
MODEL 60S — 60 GPM — GRUNDFOS

FLOW RANGE
40 to 75 GPM

PUMP OUTLET
2" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
60S20-4	2	31 ¼	3 15/16	39
60S30-5	3	40 ¾	3 15/16	64
60S50-7	5	48 ⅝	3 15/16	75
60S50-9	5	53 ¾	3 15/16	80
60S75-13	7 ½*	70	3 15/16	105
60S100-18	10*	97 ¼	3 15/16	160

Specifications are subject to change without notice.

* A 4-inch motor is provided as standard on these models.

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO.	SS1-X6
NAME	WET WELL PITLESS ADAPTORS
LOCATION	WET WELL
MANUFACTURER	Maass - Division of Surinak Engineering & Manufacturing Inc.
DISTRIBUTOR	Muskego Industrial Park S82 W19246 Appolo Drive Muskego, WI 53150 414-679-3922
DESCRIPTION	Model J Weld on Type, Drop Pipe Size 2 in. dia. for 8 in. well casing
MAINTENANCE	
COMPONENT PARTS	
SPARE PARTS	

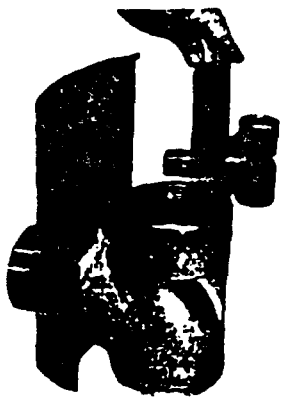
MAASS PITLESS ADAPTERS

— A full range of weld-on adapters from 1 to 4 inch

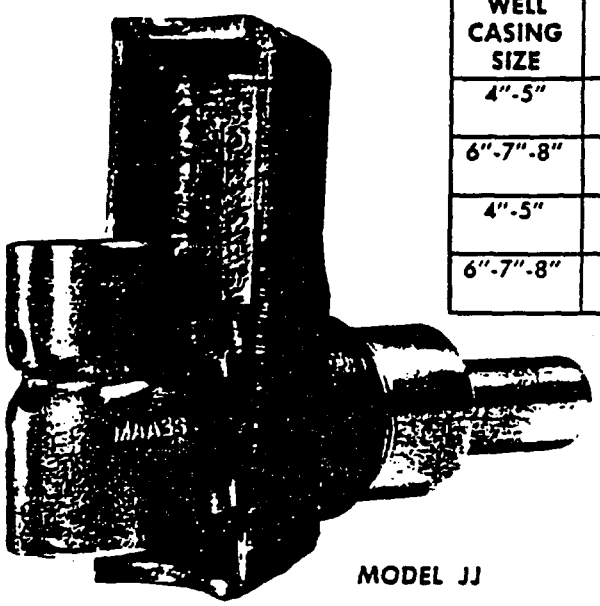
WISCONSIN STATE APPROVED
MICHIGAN STATE APPROVED
PATENTED

MAASS MODEL J PITLESSES ARE SANITARY AND EASY TO SERVICE

Recommend to your customers the Maass Model J pitlesses — units create easy well service for you because they are manufactured only of RUST-PROOF materials and designed to eliminate all obstructions in well casing. Pump is easy to pull because of non-rusting components. Water contacts only 304 stainless steel and bronze to COMPLETELY ELIMINATE ANY RUST and/or ELECTROLYSIS. The Maass pitless connection is sealed by using a bronze 8 degree non-locking taper wedge with O-ring force against 304 non-magnetic stainless steel flanged nipple pressed into steel housing and welded on outer side. Model J Pitless Adapter is non-pressure lifting and is designed for deep wells, higher working pressures, and where plastic pipe is used and high water levels. No lock necessary. Stock only two 1-inch outlet size Maass Model J pitlesses to fit all well casing sizes. Pitless steel housing is permanently installed by welding onto well casing.



MODEL J



MODEL JJ

MODEL JJ

MODEL JJ models below are for suction pumps. Lateral can be pressurized to meet state codes.

WELL CASING SIZE	MODEL	WATER OUTLET & DROP PIPE SIZE
4"-5"	JJ	1" outlet 2" lateral
6"-7"-8"	JJ	1" outlet 2" lateral
4"-5"	JJ	1¼" outlet 2" lateral
6"-7"-8"	JJ	1¼" outlet 2" lateral

WELD-ON UNITS

WELL CASING SIZE	MODEL	WATER OUTLET & DROP PIPE SIZE	APPROXIMATE WEIGHT
4"-5"	J	1"	6#
4"-5"	J	1¼"	7#
4"-5"	J	1½"	8.5#
5"	J	2"	12#
6"-7"-8"	J	1"	6#
6"-7"-8"	J	1¼"	7#
6"-7"-8"	J	1½"	8.5#
6"-7"-8"	J	2"	12#
6"-7"-8"	J	2½"	18#
8"-10"-12"	J	3"	32#
10"-12"	J	4"	50#

SEE YOUR DISTRIBUTOR OR REPRESENTATIVE FOR ADDITIONAL INFORMATION

MAASS
Division of Surmak Engineering & Manufacturing, Inc.
MUSKEGO INDUSTRIAL PARK
S82 W19246 Apollo Drive
Muskego, WI 53150
(414) 679-3922

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-V5

NAME WET WELL GATE VALVES

LOCATION WET WELL

MANUFACTURER Watts Regulator Company

DISTRIBUTOR Disney-McLane Inc.
2704 Colerain Ave.
Cincinnati, Ohio
513-541-1682

DESCRIPTION Series WGV, brass body threaded connections;
2 in. dia.

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

bronze and brass gate valves

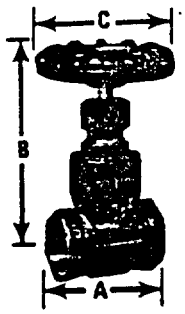
Complies with Federal Specification WW-V-54,
Type I, Class A, 85-5-5-5 construction

Series FGV-1

Federal Specification MSS SP-80
Inside screw bonnet, NRS, solid disc

Designed for continuous service on steam, water, oil and gas in either the open or fully-closed position. They are ideally suited for areas where space is a premium. Virgin PTFE packing and a gland follower. ASTM B62 body, stem and disc. Threaded IPS connections.

Pressure rating: 200 WOG
Steam rating: 125 W.S.P.



No.	Size	Dimensions (Inches) A	B	C	Master Carton Qty.	Weight (lbs.)
FGV-1, FGVS-1*	1/4"	1.66	3.05	1.88	120	60
FGV-1, FGVS-1*	3/8"	1.66	3.05	1.88	120	60
FGV-1, FGVS-1*	1/2"	1.96	3.29	2.44	96	74
FGV-1, FGVS-1*	3/4"	2.05	3.92	2.75	48	62
FGV-1, FGVS-1*	1"	2.48	4.46	2.75	42	74
FGV-1, FGVS-1*	1 1/4"	2.60	5.24	3.35	24	64
FGV-1, FGVS-1*	1 1/2"	2.77	5.59	3.74	15	46
FGV-1, FGVS-1*	2"	2.96	6.38	4.13	10	45

*FGVS-1 solder end connections

For Additional Information, send for F-BBV, GV, CV

Series FGV-UB

Federal Specification MSS SP-80
Union bonnet, rising stem, solid disc

Designed for continuous service on steam, water, oil and gas in either the open or fully-closed position. They afford free flow with minimum pressure drop. The union bonnet provides for quick valve disassembly for inspection and repair plus it reinforces the body to protect against vibration and pipeline strain. Virgin PTFE packing and a gland follower.

Pressure rating: 300 WOG
Steam rating: 150 W.S.P.

No.	Size	Dimensions (Inches) A	B	C	Master Carton Qty.	Weight (lbs.)
Threaded IPS connections						
FGV-UB	1/4"	1.75	4.13	1.88	120	60
FGV-UB	3/8"	1.75	4.13	1.88	120	60
FGV-UB	1/2"	2.13	5.00	2.44	96	74
FGV-UB	3/4"	2.24	6.10	2.75	48	62
FGV-UB	1"	2.62	7.56	2.75	42	74
FGV-UB	1 1/4"	2.87	8.62	3.35	24	64
FGV-UB	1 1/2"	3.13	10.04	3.74	15	46
FGV-UB	2"	3.52	12.13	4.13	10	45

For Additional Information, send for F-BBV, GV, CV

Series GV, GVS

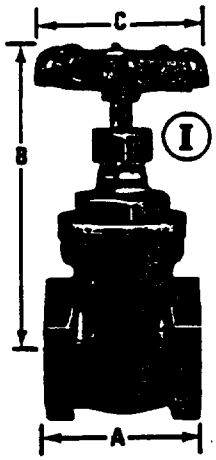
Bronze Gate Valves
For Water and Steam Service

Full rating for broad application.
125 WSP, 200 psi WOG.

Series GV have IPS threaded connections in sizes 1/4"- 4".

Series GVS have CxC sweat connections in sizes 3/8"- 3".

- Screw-in bonnet
- 85-5-5-5 bronze body



Size	DIMENSIONS (Inches) A GV	A GVS	B GV	B GVS	C GV	C GVS	Weight (lbs.) GV	Weight (lbs.) GVS
1/4"	1 5/8	–	3	–	1 15/16	–	0.62	–
3/8"	1 5/8	1 3/4	3 3/16	3 3/8	1 15/16	2 1/8	0.62	0.62
1/2"	1 3/4	1 3/4	3 3/8	3 3/8	2 3/16	2 1/8	0.71	0.62
3/4"	1 15/16	2 3/8	3 5/8	3 5/8	2 3/8	2 3/8	0.93	0.88
1"	2 1/8	2 13/16	4 7/16	4 7/16	2 9/16	2 9/16	1.2	1.15
1 1/4"	2 3/8	3	5	5	2 3/4	2 3/4	2.0	1.72
1 1/2"	2 1/2	3 3/8	5 3/8	5 7/16	3 1/8	3 1/8	2.7	1.85
2"	2 7/8	4	6 1/2	6 1/2	3 9/16	3 1/2	3.4	3.53
2 1/2"	3 1/2	4 1/2	8	8 5/16	4 5/16	4 3/8	6.4	5.95
3"	3 15/16	5 3/16	9 3/16	9 3/16	4 15/16	4 15/16	9.3	8.82
4"	4 3/4	–	10 3/4	–	5 3/4	–	18.0	–

For Additional Information, send for F-BBV, GV, CV.

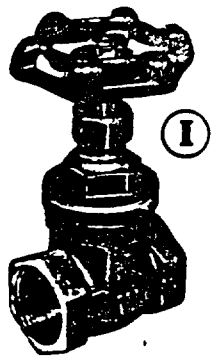
Series WGV, WGVS

Brass Gate Valves

Rating: 200 psi WOG

Series WGV have IPS threaded connections in sizes 1/2"- 4".

Series WGVS have CxC sweat connections in sizes 1/2"- 2".



Size (Inches)	DIMENSIONS (Inches) A WGV	A WGVS	B WGV	B WGVS	C WGV	C WGVS	Weight (lbs.) WGV	Weight (lbs.) WGVS
1/2	1 3/4	1 15/16	3	3	2 1/8	2 1/8	.60	.58
3/4	1 15/16	2 1/2	3 1/2	3 1/2	2 1/8	2 1/8	.82	.80
1	2 1/8	2 3/4	4 1/8	4	2 3/8	2 3/8	1.1	1.
1 1/4	2 3/8	3	4 1/2	4 1/2	2 1/2	2 3/4	1.37	1.33
1 1/2	2 3/8	3 1/2	5 3/8	5 1/8	2 3/4	2 3/4	2	2
2	2 13/16	4 1/4	6	6	3 1/4	3 1/4	3	3
2 1/2	3 1/2	—	7 3/4	—	4	—	6.25	—
3	3 7/8	—	8 7/8	—	4 7/16	—	7.75	—
4	4 3/4	—	10 1/2	—	5 1/8	—	13.50	—

For Additional Information, send for S-WGV.

(I) International Product

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X9

NAME WET WELL FLOAT SWITCHES

LOCATION WET WELL

MANUFACTURER Magnetek Controls, BW Controls

DISTRIBUTOR Nelcor Inc.
5169 Wooster Pike
Cincinnati, Ohio 45226
513-871-2816

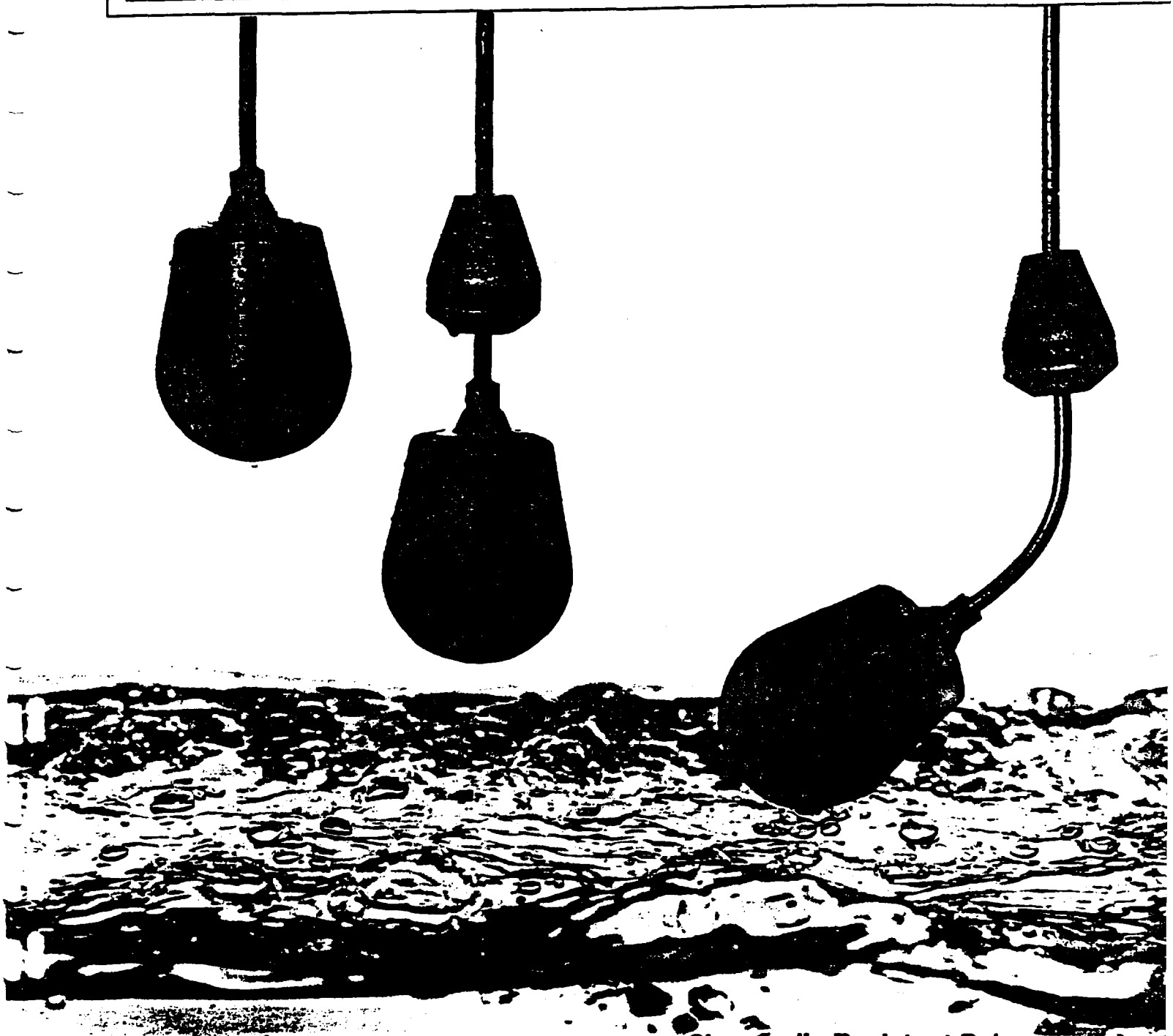
DESCRIPTION Liquid Level Float Switch Model 7010
complete with cord grip, wall mounted
bracket and 1500 series induction relay

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

LIQUID LEVEL FLOAT SWITCHES



- Hermetically Sealed Mercury Switch Provides High Reliability
- Low Cost—Easy To Install
- Ideal For Sump Pumps And Sewage Control
- Chemically Resistant Polypropylene Casing and PVC Cord
- N.O., N.C. or SPDT Contacts Available
- Switch Ratings Up to ½ HP

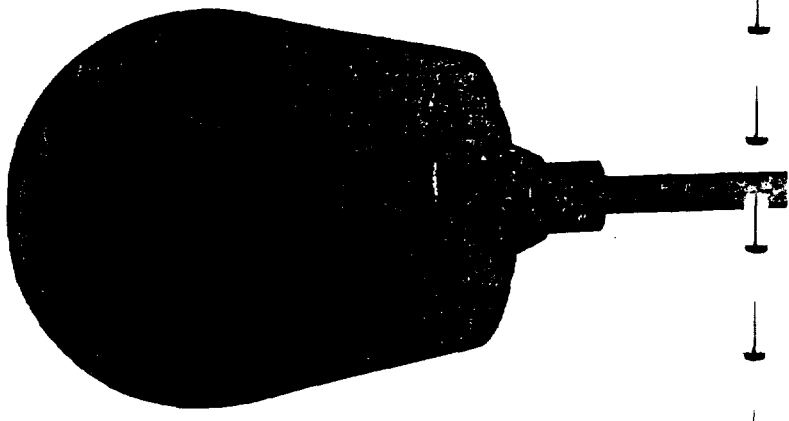
MagneTek Controls
B/W Controls
1080 N. Crooks Rd., Clawson, Michigan 48017-1097
Phone: 313 435 0700 EasyLink: 628 32092
Fax: 313 280 1544 Telex: 23 5359

October 1984

LIQUID LEVEL FLOAT SWITCHES

MagneTek Controls B/W Controls

Float:	*Chemically Stable Polypropylene*
Float Dimensions:	Length 4.0" Diameter 3.5" Strain Relief 1.0"
Cord:	Multi-conductor PVC
Cord Size:	16/3 for S.P.D.T. 16/2 for either N.O. or N.C. Operation
Cord Length:	20 ft. unless otherwise specified
Operating Temperature:	32°F to 160°F Materials are rated to 221°F
Operating Pressure:	Pressure tested to 60 feet of water (26 psi.)



Switch Ratings:

Switch Code		Running Current (Amps) at 120 VAC	Running Current (Amps) at 240 VAC
Wide Angle	A	20.0	15.0
Narrow Angle	G L	1.0 15.0	.7 11.0
Narrow Angle S.P.D.T.	W	15.0	11.0

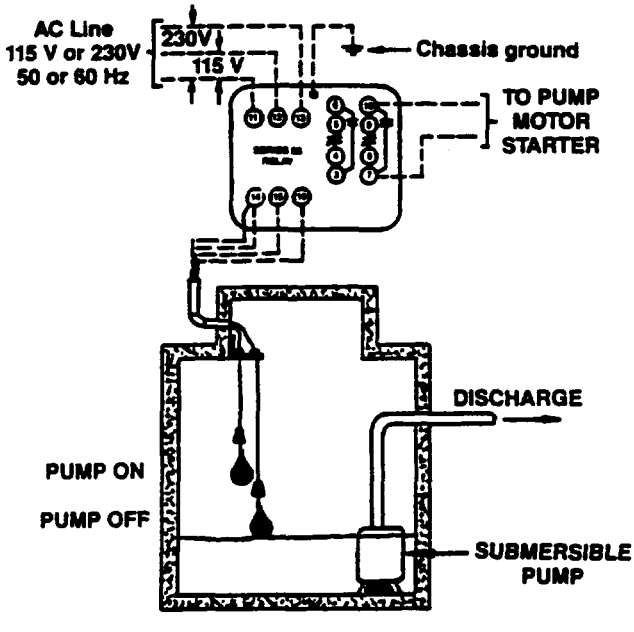
DESCRIPTION

The B|W Float Switches are mercury-switch actuated liquid level controls, designed to operate pumps, valves, chlorinators, multiple pump alternators, relays, contactors, alarms and similar equipment for industrial and commercial use.

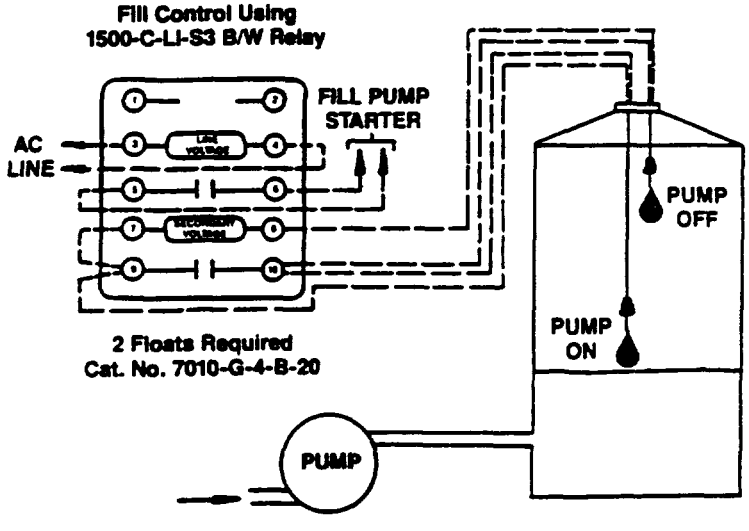
A hermetically sealed, axially non-position sensitive mercury switch inside the polypropylene float, provides a reliable long lasting level control suitable for most liquid environments up to 160°F.

The B|W Float Switches provides an ideal pilot device for the control of all B|W Control relays and control panels. The polypropylene float, Nitrile Gasket, PVC cable and hermetically sealed mercury switch, provides an economical liquid level solution for controlling sewage, effluent, many chemical solutions and in other hostile environments containing oil, grease or other similar industrial and municipal wastes where dependable liquid level control is essential.

Pump Down Control Using Intrinsically Safe Relay Model 5300-S-F1
2 Floats Required:
Cat. No. 7010-G-4-A-20



Fill Control Using 1500-C-LI-S3 B/W Relay



2 Floats Required
Cat. No. 7010-G-4-B-20

MagneTek Controls B/W Controls
1080 N. Crooks Rd., Clawson, Michigan 48017-1097
Phone: 313 435 0700 EasyLink: 628 32092
Fax: 313 280 1544 Telex: 23 5359

CATALOG NUMBERING SYSTEM

7010 — G — 4 — A — 20

Catalog Section

	Float Size
4	3½" Diameter

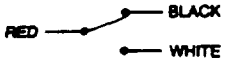
	Contact Arrangement
A	N.O. — Normally open for Pump Down
B	N.C. — Normally closed for Pump Up
*C	S.P.D.T. — Single Pole Double Throw for both pump up or pump down

*Applies only in "W" switch types.

	Switch Type			
	Running Current (Amps)		Operating Angle	List Price
	120 VAC	240 VAC		
	Wide Angle N.O. or N.C.			
A	20.0	15.0	120°	$82.00
	Narrow Angle N.O. or N.C.			
G	1.0	0.7	15°	$71.50
L	15.0	11.0	10°	$78.50
	Narrow Angle SPDT			
W	15.0	11.0	18°	$110.00

} S.P.D.T. Contact Configuration

Note: When using B|W relays, specify Type G Switch. Switches stocked in 20 foot lengths.



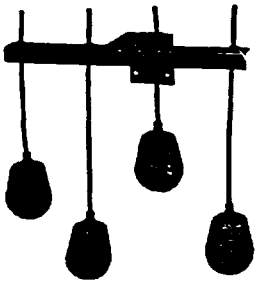
	Cord Length	List Price
20	20 ft. is standard	No Addition
	Specify other special length	Add $1.25/ft.** Over 20 ft.

**Special lengths must be ordered in quantities of 50 units or more.

ACCESSORIES

Float Switch Weight (20 ounces)
Part No. 12-085000
List Price $12.00

½" Cord Grip for Single Float Switch Part No. 12-084900
List Price $12.00



Wall Mount Bracket For up to 4 Float Switches
Part No. 12-085100
List Price $29.00

Wall Mount Bracket For Single Float Switch
Part No. 12-085200
List Price $9.50

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X8

NAME WET WELL FLOW INDICATORS

LOCATION WET WELL

MANUFACTURER Badger Meter Inc.

DISTRIBUTOR W.R. Frew
Cincinnati, Ohio
513-561-3669

DESCRIPTION Badger Inc. flow indicator, Model OP, 2" Ø, bronze body, Kynar piston, flanged ends, range 20-100 gpm, equiped with : Model PFT-420 flow transmitter; remote reading Model ER-7R single indicator for flow rate (to be installed @ wet well); remote reading Model ER-7R single indicator for totalization (to be installed @ treatment plant)

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

Model OP Chemical and Sanitary

Industrial Oscillating Piston Meter

Technical Brief

GENERAL

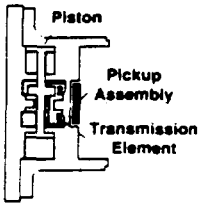
Badger's positive displacement meters, model OP are one of the most cost effective methods for metering process fluids in the chemical, pharmaceutical and food industries. The simple but efficient design of the OP meter generates high accuracy and repeatability over the entire meter flow range. Magnetic, "through the wall" transmission, prevents operator exposure to corrosive fluids and protects the fluid from external contamination.

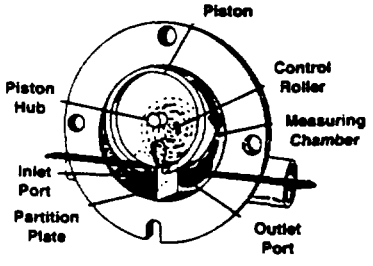
Offered in three sizes, 1/2", 1" and 2", for flows up to 100 GPM, these meters are extremely rugged, reliable and need little maintenance and calibration. With only three internal moving parts, maintenance is seldom required. If necessary, it takes but a few minutes. All parts are designed and built of materials recommended for your application, providing you with a long life, trouble-free, precision flow meter. All sizes of the meter are offered in chemical and sanitary, 3A approved, configurations with a wide variety of end fittings to match your piping. Their compact design and mode of operation allows for installation in tight spaces and in any position.

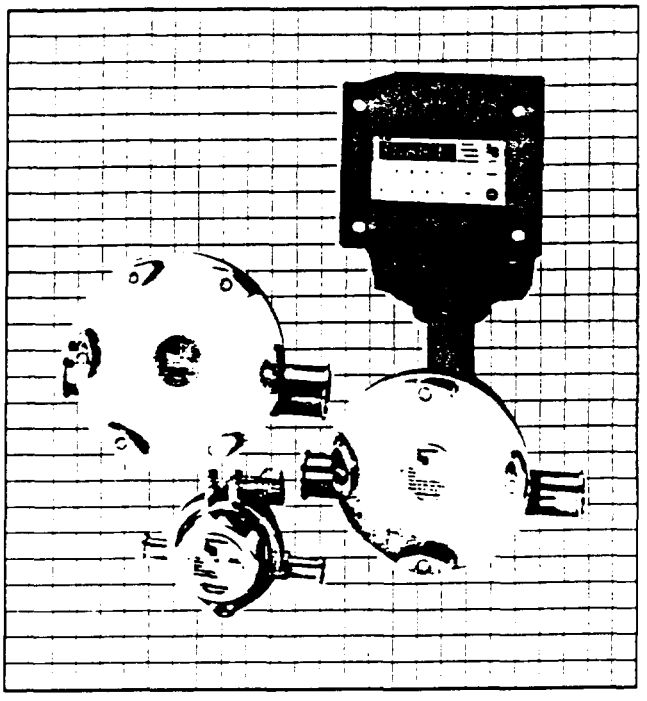
To complement the OP meter line, Badger offers a complete line of accessories that includes mechanical, pneumatic, electromechanical and electronic transmitters, totalizers, indicators and batch/process controllers.

OPERATION

The meter function is based on the continuous filling and discharging of the measuring chamber (positive displacement). Controlled clearances between the piston and the chamber insure minimum gap leakage for precise measurement of each volume cycle. As the piston oscillates, its' center hub rotates a magnet, whose movement is sensed through the meter wall by electromagnetic sensors or by a follower magnet. Each revolution of the magnet is equivalent to a fixed volume of fluid, which is converted to any engineering unit of measure for totalization, indication or process control.





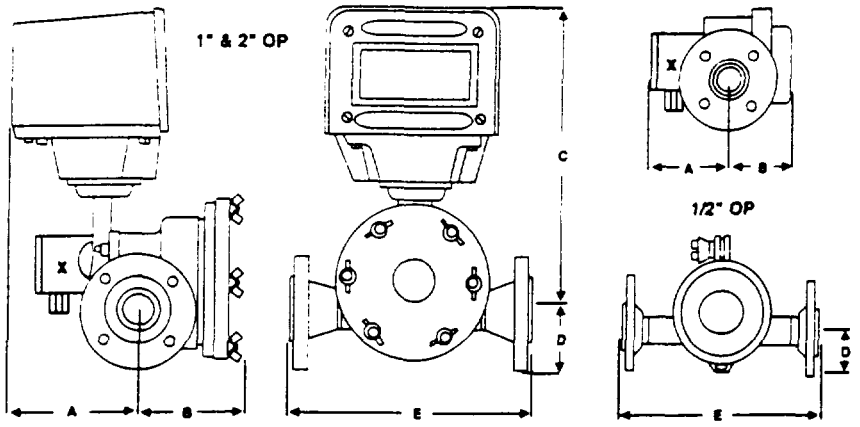


MATERIALS OF CONSTRUCTION

	1/2"	1"	2"
BODY MATERIALS:			
316 SS (raised face flanges)	x	x	x
Brass (flat face flanges)		x	x
PISTON MATERIALS:			
Polypropelene (hi or low temp.)		x	x
Kynar (hi or low temp.)	x	x	x
Ryton (one temp.)	x	x	x
Carbon (one temp.)		x	x
Kel-F (hi or low temp.)		x	x
"O" RING MATERIALS:			
Buna N	x	x	x
EPR	x	x	x
Viton	x	x	x
Teflon	x	x	x
NPR	x	x	x
Butyl	x	x	x
BUSHING MATERIAL:	Rulon		
MAGNET CASING:	Alloy 20		
CONTROL ROLLER:	Alloy 20		

Badger Meter, Inc.
Industrial Division

Bulletin No. ITB-050-06
April 1992



	1/2"	1"	2"
A	4.31"	6.16"	6.63"
B	2.32"	3.81"	5.56"
C		15.83"	16.21"
D	1.75"	2.87"	3.00"
E	6.75"	11.00"	12.62"
E*	6.75"	11.00"	11.81"
E**	6.75"	11.00"	12.13"

* Tri-Clamp/Cherry Burrel
** IMDA

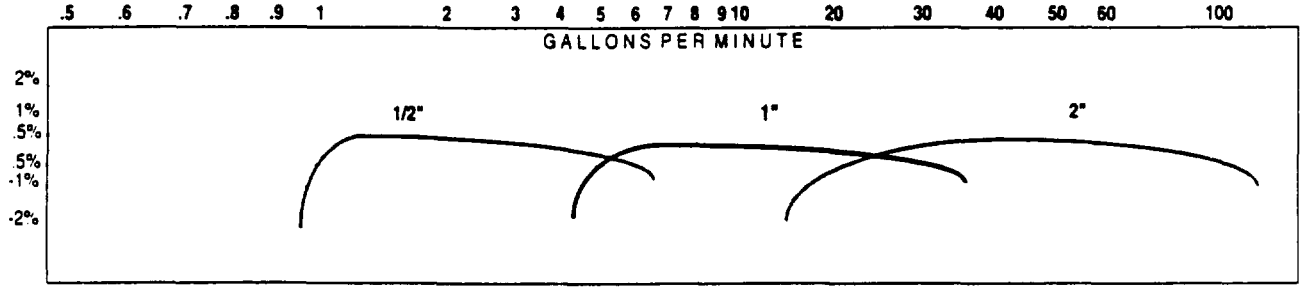
Dimensions shown are of meter with angle drive and PC meter mount or with rear drive and transmitter.

Dimensions for other system configurations may vary slightly. Please consult with factory

OPERATING & PERFORMANCE SPECIFICATIONS

	1/2"	1"	2"
• **Minimum Flow Rate, Q Minimum:**	1 gpm	5 gpm	20 gpm
• **Continuous Operating Maximum Rate:**	4 gpm	20 gpm	65 gpm
• **Short Duration Maximum Flow, Q Maximum:**	6 gpm	30 gpm	100 gpm
Continuous operation is acceptable at these rates but accelerated wear of the piston and/or bushings may occur.			
• **Standard Flange Connections*, Chemical:**	150/300* psi ANSI 16.5	150 psi ANSI 16.5	150 psi ANSI 16.5
• **Standard Connections, Sanitary:**	Tri-Clamp	Tri-Clamp IMDA threaded Cherry Burrel I or Q	Tri-Clamp IMDA threaded Cherry Burrel I or Q
Sanitary OP meters have 3A approval. Polypropelene (1" & 2" only) or Kynar piston is required.			
* 1/2" Chemical meter can be ordered with 1" flanges for low flow applications on 1" lines. All sizes available with optional 300 psi flanges.			
• ***Pressure Drop at Maximum Flow:*** (@ viscosity & specific gravity of water)	1.7 psi	4 psi	8 psi
• **Maximum Viscosity Limit:**	Pressure loss increases with fluid viscosity 10,000 cps (flow range is decreased as viscosity increases)		
• **Maximum Operating Pressure:**	150 psi for 316SS - 100 psi for Brass		
• ***Maximum Operating Temperature:***	250° F on high temp. pistons / 120° F on low temp. pistons		
• **Minimum Operating Temperature**:**	Limited by piston material, recommended 40° F		
**Minimum temperature for stated accuracy			
• **Accuracy :**	± 0.5% over entire meter flow range		
• **Repeatability:**	± 0.2% or better under similar repeatable batch operations		

Metric Conversion: psi x 0.0703 = BARS gpm x 3.785 = liters per minute °F - 32 x .555 = °C



ACCURACY CURVES Accuracy tested in ambient temperature. Higher accuracy may be achieved with more viscous fluids.

Badger Meter, Inc. Industrial Division
4545 W. Brown Deer Road, P. O. Box 23099 Milwaukee, WI 53223-0099
Telephone: (414) 355-0400 • Voice Mail: (414) 355-0410, Extension 637
Fax: (414) 355-7499 • Telex: WU 2-6757 – RCA 201313

Model ER-7 & ER-7/R (Remote) Digital Resettable Totalizer or Digital Rate of Flow Indicator

Technical Brief

GENERAL

Badger's Model ER-7 register is a meter mounted totalizer/rate indicator designed for use with Badger's HPV™ series of flow meters. The ER-7/R is the remote version and can be used with any Badger flow meter when equipped with compatible unscaled pulse transmitters. A rear adapter plate is provided with the remote version for attachment to a wall or other suitable surface. The ER-7 series registers are available with one or two indicators. Either indicator can be programmed as a rate-of-flow indicator or as a resettable totalizer. If you require simultaneous display of rate-of-flow and totalization, you must order the register with two indicators.

The registers are battery powered. They get their input pulses from the proximity sensor located within the HPV meter or from the meter pulse transmitter, if you are using the remote version. Proximity sensors and other electronic sensors with open collector outputs must be externally powered.

DESCRIPTION

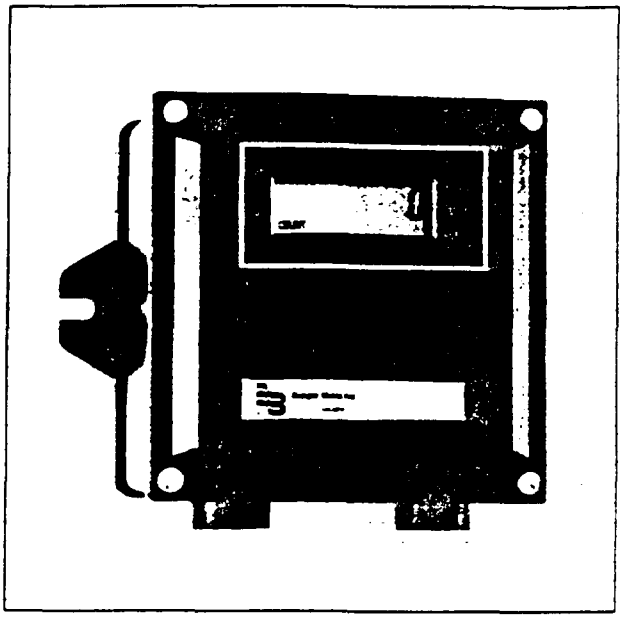
The indicators utilize the latest LSI technology. They have crisp, 8 digit numeric LCD displays. Step by step programming is similar to programming a digital watch, and can be done from the front panel. Upon completion of the procedure, reprogramming can be inhibited by repositioning a jumper located on the rear of the unit.

When the indicator is programmed as a totalizer, the display can be reset to zero from the front panel switch or from an external switch wired directly to the rear connector. The front panel reset button can be inhibited by repositioning a rear jumper.

A programmable pre-counter allows you to indicate in any engineering unit of measure. (Gallons, pints, pounds, etc.) You can read to the nearest 0.1 or 0.01 unit depending on the type and size of the flow meter.

Operation

Fluid flowing through the meter causes pulses to be generated by the sensor or transmitter. Each pulse represents a specific volume of fluid. Using the 1" HPV meter as an example, 444 pulses are generated every time one gallon of fluid passes through the meter. If you program the pre-counter for 0444, the least significant digit on the display will increment once every time the register counts 444 pulses. You would be able to measure to the nearest gallon.

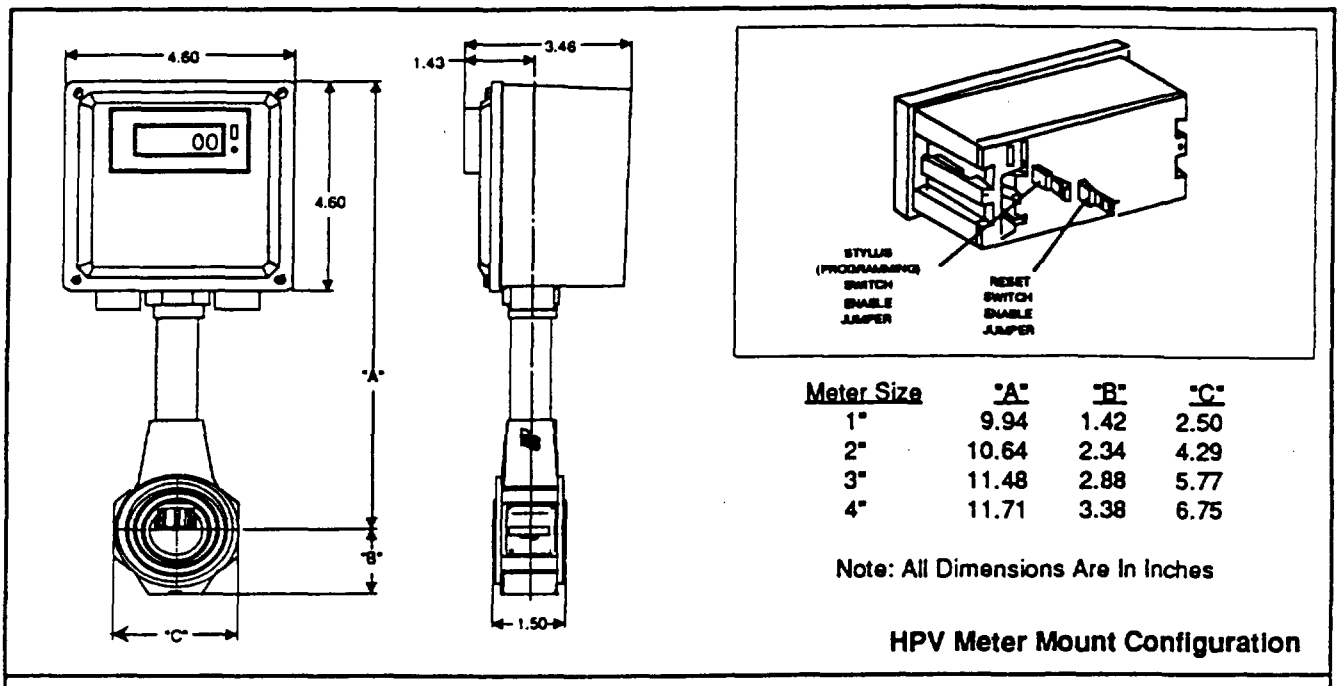


ER-7-R with rear adapter plate

Features

- All Solid State Components For Long Life
- Displays Are Battery Powered For Memory Retention
- Corrosion Resistant Plastic Housing Built To NEMA 4X Specifications
- Programmable For Rate of Flow or Totalization
- Programmable Pre-Counter
- Front Panel Totalizer Reset Switch Can Be Disabled
- Front Panel Programming Can Be Inhibited

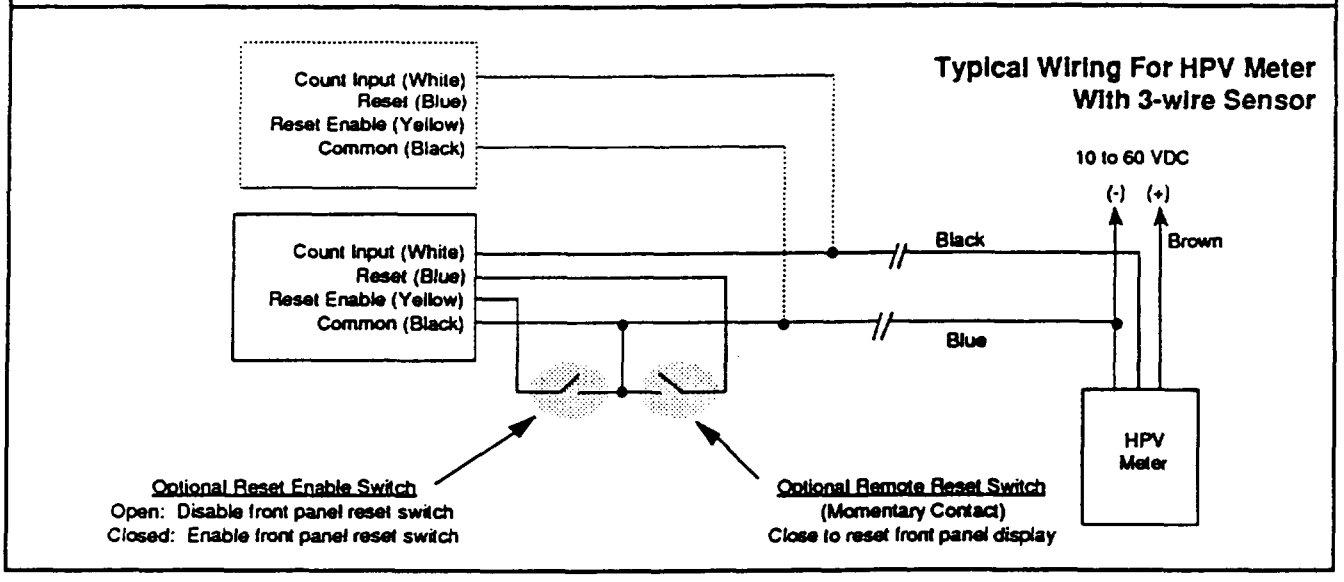
Badger Meter, Inc. Industrial Division
4545 W. Brown Deer Road, P.O. Box 23099, Milwaukee, WI 53223-0099
(414) 355-0400 Fax: (414) 355-7499 Telex: WU 2-6757 — RCA 201313



Meter Size	"A"	"B"	"C"
1"	9.94	1.42	2.50
2"	10.64	2.34	4.29
3"	11.48	2.88	5.77
4"	11.71	3.38	6.75

Note: All Dimensions Are In Inches

HPV Meter Mount Configuration



ER-7 & ER-7/R SPECIFICATIONS

POWER SOURCE:
Indicators: 3 volt Lithium battery lasting up to 8 years.

DISPLAY: Eight digit LCD with .35" high characters

OPERATING TEMP:
Indicator: 32° F to 167° F

ACCURACY: ±.01%, ±1 DIGIT for RATE

INPUTS: Low speed (reed Switch) input can operate up to 25 counts per second.

High Speed (electronic sensors) input can operate up to 5000 counts per second when driven with a 50% duty cycle.

TYPES: TTL, CMOS, open collector sink, relay contact to common, magnetic pickups having > 2.0 VOLTS peak output into 10KΩ load or any signal source that can supply the following DC voltages:
Input HIGH is > 2.0 volts.
Input LOW is < 1.0 volt.
Maximum input voltage is ± 28 volts.

REMOTE RESET: Forces reset when pulled below 1.0 v.

Model FT-420 & PFT-420 (Two-Wire, 4-20 ma DC and Pulse) Flow Transmitter

Technical Brief

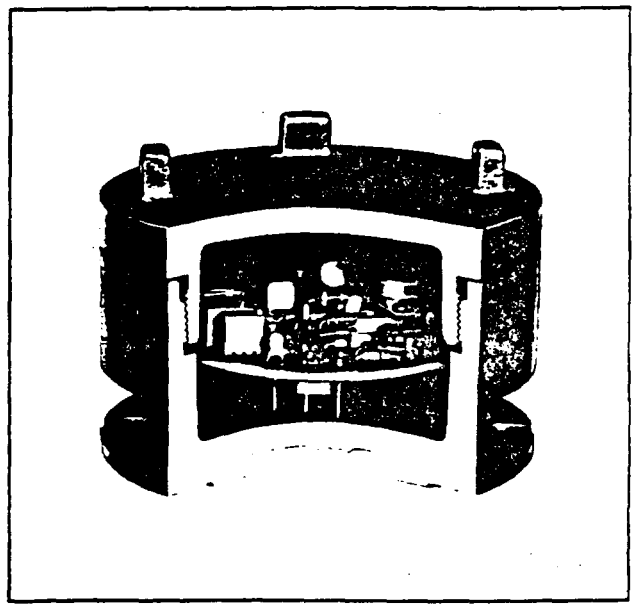
General

The model FT-420 & PFT-420 are versatile electronic flow transmitters for use with Badger's complete line of flow meters. These solid state units produce a 4-20 ma DC output signal through a two-wire design. They also provide a transistor switched pulse-rate signal.

The two-wire, 4-20 ma DC signal is directly proportional to the flow rate in the meter and is completely isolated, preventing the formation of ground loops. The signal has excellent linearity, accuracy and repeatability as well as being resistant to internal and external electric interference.

The isolated, pulse-rate signal is generated by an open collector transistor. It has a square wave format which provides positive pickup of the flow meter's pulse-rate.

By nature of the electronic pickup, the FT-420 & PFT-420 significantly reduce mechanical load on the flow meter extending, in most cases, the operational flow range and improving the accuracy of the meter.



Applications

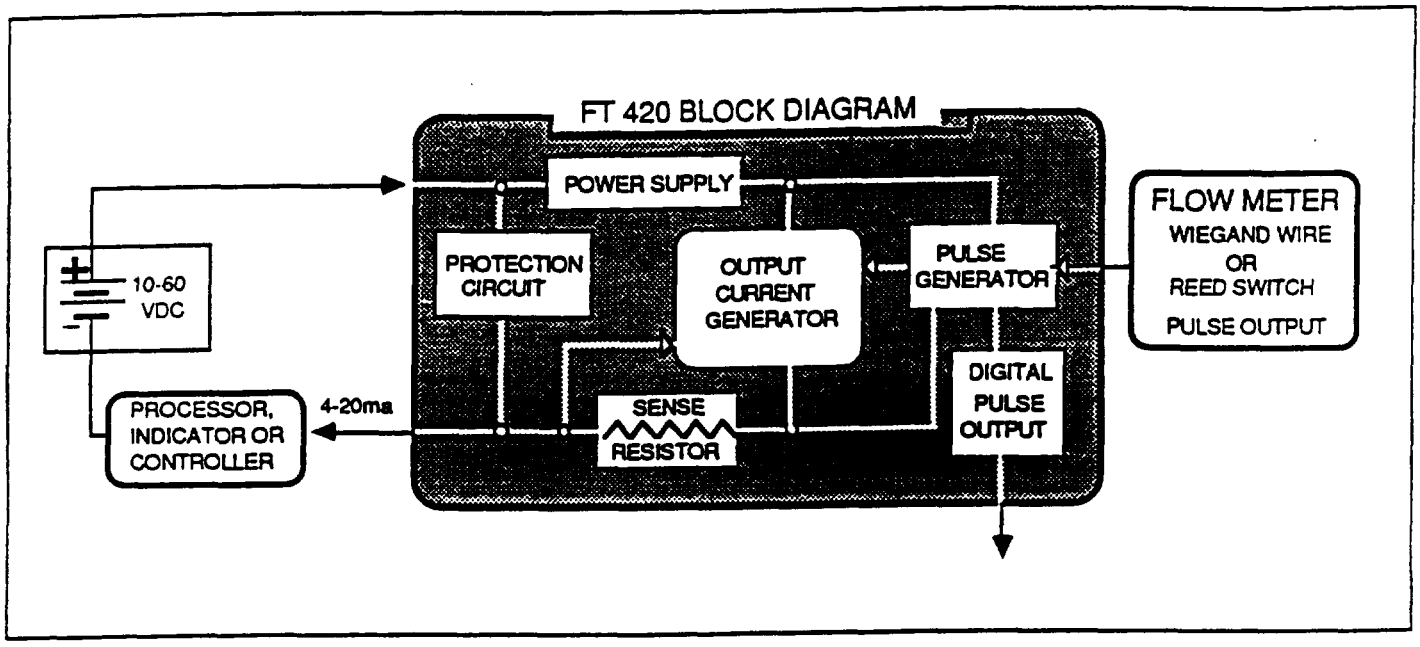
In general, these flow transmitters can precisely condition and transmit flow meter signals for process control in the chemical, food & beverage, water conditioning, pharmaceutical and any other industry where precise measurement and control of fluid flow is required. Twin outputs can be applied to:

- **Totalize and indicate flow**
- **Batch and regulate flow**
- **Provide signal to hi-low flow controllers**
- **Signal process computors**

Operation

The FT-420 & PFT-420 flow transmitters accept pulse signals generated by either a Wiegand wire / magnet or by a reed switch / magnet interaction in the flow meter. The pulse input is then decoded and standardized by a pulse form network. A current regulator accepts the standard signals and converts the pulse rate into a steady current signal (4-20ma) directly proportional to the rate of flow of the fluid through the meter; 4 ma representing zero flow and 20 ma representing full flow (user can adjust span to suit application). Power for the device is derived from the 10-60 DC supply, 4 ma "zero" current. Each input pulse is also repeated on the isolated transistor switch in a square wave format. Two-wire connections are provided for each of the two signal outputs.

J•M INDUSTRIAL SUPPLY LIMITED
2899 Steeles Avenue West, Unit 4
Downsview, Ontario M3J 3A1
Tel. (416) 665-2300
Telex 06-217758



GENERAL SPECIFICATIONS

ENVIRONMENTAL

Operating Temperature: -20°F to 250°F
Humidity: 5% to 100% non-condensing
Enclosures: NEMA 4 & 4X

ELECTRICAL

Inputs
Supply Voltage: 10 to 60 VDC
Pulse Input:
Circuit Interface: Transformer isolated
Pulse magnitude: (0.5 to 5 VDC)
Pulse Polarity: Pos. or Neg. @ 200 Hz max.
Alternating pos/neg. pulse @ 100 Hz max.
Switch Closure: 40 to 60% duty cycle @ 100 Hz

Outputs
Digital
Opto-isolator: Open collector transistor
Max. Voltage: 40 VDC
Max. Current: 20 ma @ 0.5 VDC
Pulse Width: 1 millisecond (± 0.1 msec.)
Pulse Rate: Input rate X 2

Analog
Two-wire signal/power
Max. Voltage: 10 to 60 VDC supply
Current: 4 to 20 ma
Max. Load Resistance (ohms) = 50+[50x(VDC-10)]

PERFORMANCE

Analog Output
Two-wire (signal/power) circuit interface with reversed polaruty protection.

Accuracy: Within 0.5% of point (10:1 range)
Repeatability: Within 0.2% of point
Max. Ripple: 0.1 ma @ 10% of span calabration
Response: 3 sec. to within 95% of total change

Operatioinal Drift: Less than 10 microamps
Thermal Drift: Less than 1 microamp per ° C

O.V. Protection: 82 volt MOV, 2.5 watt-sec

Span Adjustment: 10 to 30 ma
Zero Adjustment: 3 to 12 ma
Zero Stability: 3.97 ma to 4.03 ma

REPRESENTATIVE:

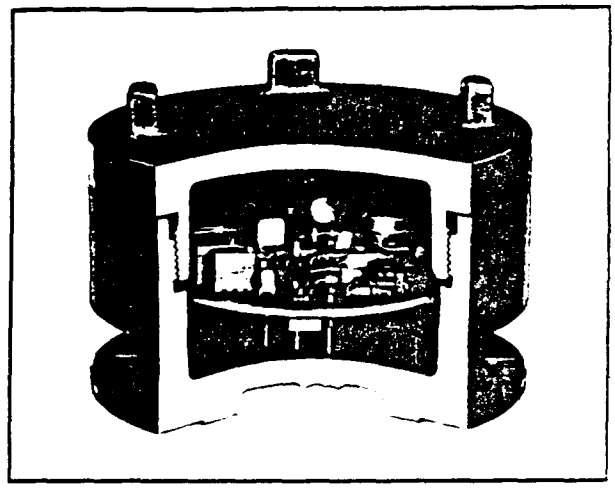
Models FT-420 & PFT-420 series

Digital and Analog Flow Transmitter

Installation & Operation Brief

Description

The series of FT 420 & PFT 420 flow transmitters are usually assembled and mounted to the flow meter. However, they can be retrofitted on top of an already installed meter, including all magnetically driven models of OP, Turbo, Disc and Propeller meters. They are housed in a bronze housing similar to the MSE5 & EPT1 (Model FT 420) transmitters, an aluminum housing similar to the MSE1 (Models FT 420 1& FT420 R) or a high impact resistant plastic housing (Models PFT 420, 420/1, 420/2 & 420/R) depending on the meter/ transmitter configuration. See Bulletin IRP-049-02. It can also be mounted inside the PC-100 meter mounted housing.



Operation

The FT 420 & PFT 420 series have both pulse and analog outputs. The pulse output is generated by an open collector transistor, and it is equivalent to the scaled (or unscaled) pulse rate received from the main pickup element or retransmitting pulser. The analog output is a two wire 4-20 ma signal proportional to flow rate. It is normally calibrated at the factory to produce 4 ma at zero flow and 20 ma at any flow up to the maximum flow rate of the meter. Special calibration can be done at the factory on request or it can easily be done in the field.

Mounting

The FT 420 or PFT 420 unit directly replaces the MS-E1 pulse transmitter on Turbo meters and the MS-E5 on OP, Disc and propeller meters. Depending on the PFT model selected, a simple plastic adapter may be required. For Turbo meters, it is necessary to replace the gear adapter with a Wiegand wire adapter and make sure that the rotor assembly in the meter contains a 4 pole instead of a 2 pole magnet. The transmitter can also be operated in a remote location (model FT 420/R & PFT 420/R). However, this can only be done with the following transmitters: FT1, FT2, PFT2 and MS series transmitters.

METER K FACTOR CHART

Meter Size	Meter Model	20 ma at GPM	Pulses per Gallon
5/8"	SC-ER Disc	20	320.00
3/4"	SC-ER Disc	30	265.76
1"	SC-ER Disc	50	86.88
1-1/2"	SC-ER Disc	100	38.16
2"	SC-ER Disc	160	20.08
1/2"	OP piston	5	445.92
1"	OP piston	30	153.28
2"	OP piston	100	41.12
2"	Turbo	160	34.72
3"	Turbo	350	24.80
4"	Turbo	1000	5.12
6"	Turbo	2000	2.16
4"	Propeller	450	12.16
6"	Propeller	1000	3.20
8"	Propeller	1200	1.79
10"	Propeller	1600	1.06
12"	Propeller	2250	0.74
14"	Propeller	3000	0.54

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Calibration

The FT 420 & PFT 420 analog signal is calibrated at the factory, relative to the standard flow rate of the accompanying meter(i.e. 2" Turbo 4ma at no flow and 20ma at 160 GPM.) The customer can recalibrate the unit to suit his own application. To recalibrate the unit first remove the transmitter cover. Connect a milliammeter (VOM or Simpson) as shown.

- Connect a pulse counter on the pulse output and count the number of pulses received in one minute. (Refer to meter factor table, to determine flow rate).
- Increase your fluid flow to the rate at which 20 ma output is desired.
- Using a small screwdriver adjust SPAN pot clockwise to increase analog output and counterclockwise to decrease it.

Example: Pulse counter registers 1260 pulses per minute on a 2" Turbo meter. A 2" Turbo has a K factor of 18 pulses per gallon. Thus, 1260/18 =70 GPM. Customer requires 20 ma at 75 GPM. Therefore, he adjusts system to increase flow and obtain 1350 pulses per minute (75 x 18). Once this is done the SPAN pot can be adjusted to 20 ma using the milliammeter.

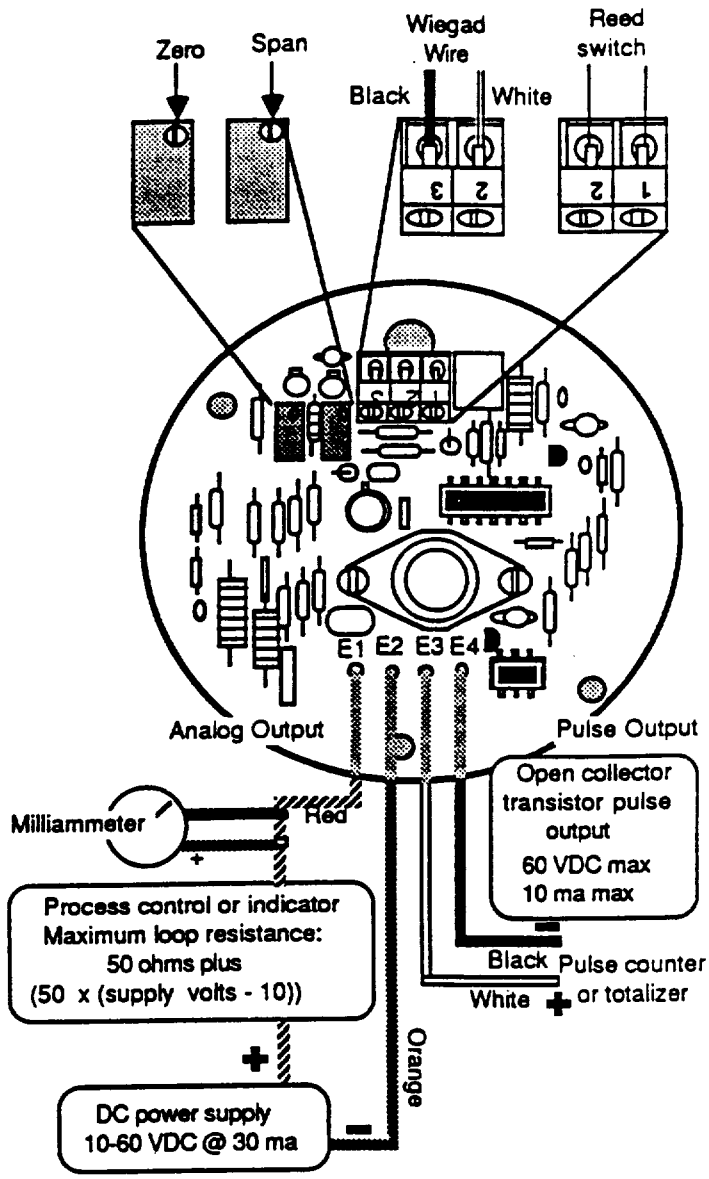
WIRING PROCEDURE

Signal Inputs:

The circuit board contains an input terminal block with three screw terminals. Use terminal #1 & #2 to connect the two wires from a reed switch pickup or transmitter such as the two wires coming up through the OP right angle drive or an MS series transmitter on a remote FT420/R. Use terminals #2 & #3 to connect the Wiegand wire pickup from a Turbo meter adapter.

Signal Outputs:

The transmitter board has four signal output wires. A black and a white for pulse output and a red and orange for the analog output.
-Analog Output:
Connect the RED wire to the positive terminal of the DC supply on the indicator or controller and the ORANGE wire to the negative terminal.
-Digital Output:
Connect the WHITE lead to the positive terminal of the counter or controller and the BLACK to the negative terminal.



WARRANTY

Badger warrants all meters and parts manufactured by it and supplied hereunder to be free from defects in materials and workmanship for 18 months from date of shipment or 12 months from date of installation whichever period shall be shorter. If within such period any meters or parts shall be proved to Seller's satisfaction to be defective, such meters or parts shall be repaired or replaced at Seller's option. Seller's obligation hereunder shall be limited to such repair and replacement and shall be conditioned upon Seller's receiving written notice of any alleged defect within 10 days after its discovery and, at the Seller's option, return of such meters or parts to Seller f.o.b. its factory.THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESSED OR IMPLIED WARRANTIES INCLUDED BUT NOT LIMITED TO IMPLIED WARRANTIES (EXCEPT FOR TITLE) OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE. Badger shall not be liable for any defects attributable to acts or omissions of others after shipment, nor any consequential, incidental or contingent damage whatsoever.

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-V4

NAME WET WELL FLOW CONTROL BALL VALVES

LOCATION WET WELL

MANUFACTURER Worcester

DISTRIBUTOR

DESCRIPTION Flow control ball valve, 2" Worcester #CPT 4466PMS EG60, all stainless steel, screwed ends 60 Deg. equipped with: Worcester #2275-4W 120 VAC Electric Actuator, NEMA IV Housing, 75% Duty Cycle Motor; #HQ99 set point controller designed to accept 4-20MA signal from flow indicator; #MK026 S6 mounting kit to couple valve and actuator

MAINTENANCE

COMPONENT PARTS

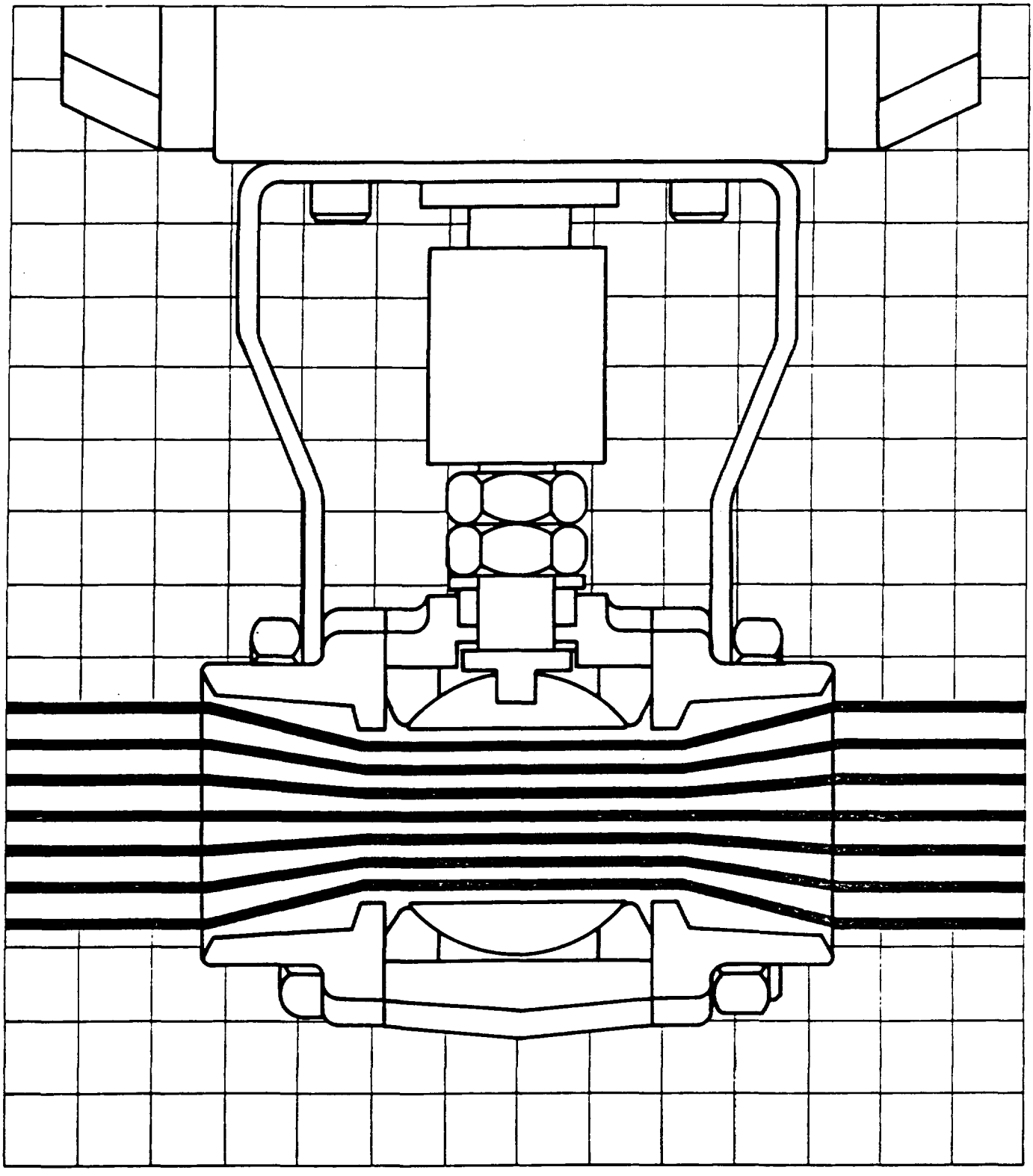
SPARE PARTS

Worcester Controls
A BTR Company

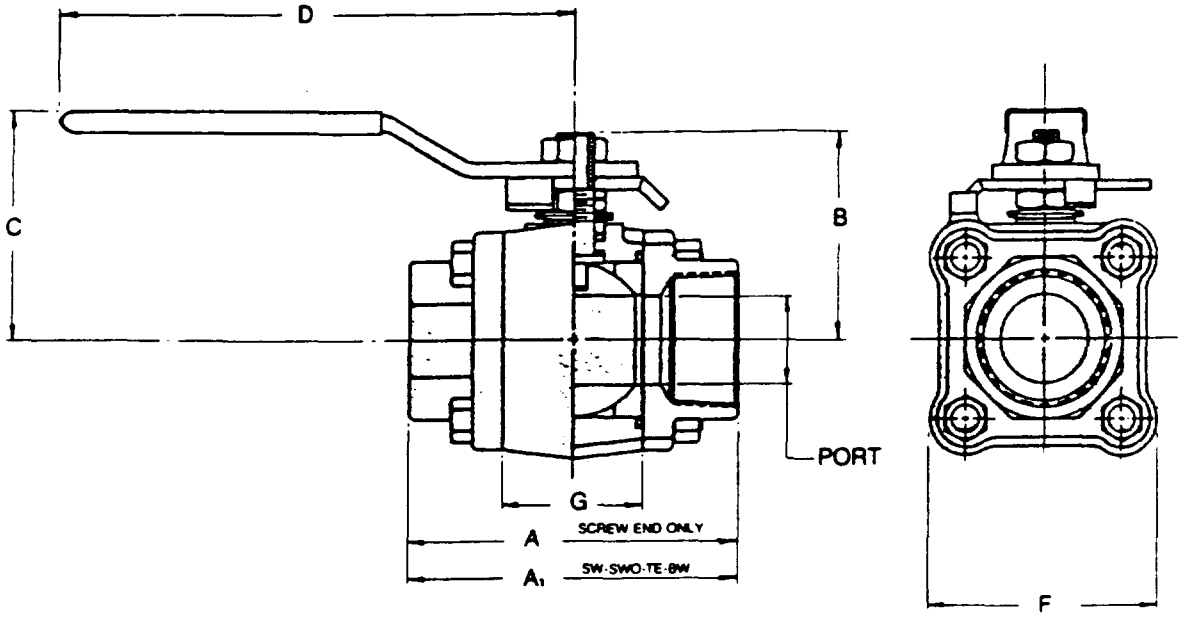
Series 44 Ball Valves

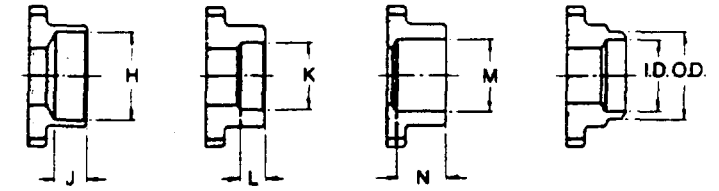
3-piece ball valves that meet all requirements for material compatibility, shutoff, end connections and safety.

PB-401-26



Dimensions





SOCKET WELD SW | O.D. TUBE END SWO | TUBE END TE K, L, OR M (Copper Tube) | BUTT WELD BW SCH. 5, 10 (Stainless Steel) SCH. 40 (Carbon Steel)

Inches (mm)

Valve Size	A	A1	B	C	D	F	G	H	J	K	L	M	N	Sch.5 O.D.	Sch.5 I.D.	Sch.10 O.D.	Sch.10 I.D.	Sch. 40 O.D.	Sch. 40 I.D.	Port	Approx. Weight lbs. (kg)
¼"	2.57 (65.28)	2.50 (63.50)	1.50 (38.10)	1.81 (45.97)	4.40 (111.76)	1.75 (44.45)	.813 (20.65)	.555 (14.10)	.44 (11.18)	— —	— —	.378 (9.60)	.44 (11.18)	— —	— —	.55 (13.97)	.406 (10.31)	.55 (13.97)	.344 (8.74)	.44 (11.18)	1.25 (.6)
⅜"	2.57 (65.28)	2.50 (63.50)	1.50 (38.10)	1.81 (45.97)	4.40 (111.76)	1.75 (44.45)	.813 (20.65)	.690 (17.53)	.44 (11.18)	— —	— —	.503 (12.78)	.56 (14.22)	— —	— —	.67 (17.02)	.547 (13.89)	.67 (17.02)	.516 (13.11)	.44 (11.18)	1.25 (.6)
½"	2.57 (65.28)	2.50 (63.50)	1.50 (38.10)	1.81 (45.97)	4.40 (111.76)	1.75 (44.45)	.813 (20.65)	.855 (21.72)	.44 (11.18)	.510 (12.95)	.44 (11.18)	.628 (15.95)	.56 (14.22)	.84 (21.33)	.71 (18.03)	.84 (21.33)	.672 (17.07)	.84 (21.33)	.625 (15.87)	.44 (11.18)	1.25 (.6)
¾"	2.79 (70.87)	2.73 (69.34)	1.62 (41.15)	1.88 (47.75)	4.40 (111.76)	2.10 (53.34)	.969 (24.61)	1.065 (27.05)	.56 (14.22)	.760 (19.30)	.56 (14.22)	.878 (22.30)	.77 (19.56)	1.05 (26.67)	.920 (23.36)	1.05 (26.67)	.875 (22.22)	1.05 (26.67)	.812 (20.62)	.56 (14.22)	1.75 (.8)
1"	3.69 (93.73)	3.62 (91.95)	2.19 (55.63)	2.44 (61.98)	5.75 (146.05)	2.38 (60.45)	1.250 (31.75)	1.330 (33.78)	.72 (18.29)	1.010 (25.65)	.56 (14.22)	1.128 (28.65)	1.00 (25.40)	1.31 (33.27)	1.18 (29.97)	1.31 (33.27)	1.094 (27.79)	1.31 (33.27)	1.049 (26.64)	.81 (20.57)	3.00 (1.4)
1¼"	4.19 (106.43)	4.12 (104.65)	2.38 (60.45)	2.62 (66.55)	5.75 (146.05)	2.62 (66.55)	1.625 (41.27)	1.675 (42.54)	.72 (18.29)	1.260 (32.00)	.56 (14.22)	1.378 (35.00)	1.00 (25.40)	1.66 (42.16)	1.53 (38.86)	1.66 (42.16)	1.437 (36.50)	1.66 (42.16)	1.380 (35.05)	1.00 (25.40)	4.00 (1.8)
1½"	4.53 (115.06)	4.47 (113.54)	2.88 (73.15)	3.12 (79.25)	7.00 (177.80)	3.00 (76.20)	1.906 (48.41)	1.915 (48.64)	.72 (18.29)	1.510 (38.35)	.56 (14.22)	1.629 (41.38)	1.11 (28.19)	1.91 (48.51)	1.77 (44.96)	1.91 (48.51)	1.672 (42.47)	1.91 (48.51)	1.594 (40.49)	1.25 (31.75)	6.00 (2.7)
2"	4.98 (126.49)	4.90 (124.46)	3.06 (77.72)	3.31 (84.07)	7.00 (177.80)	3.38 (85.85)	2.218 (56.34)	2.406 (61.11)	.84 (21.33)	2.012 (51.10)	.72 (18.29)	2.129 (54.08)	1.09 (27.69)	2.38 (60.45)	2.24 (57.02)	2.38 (60.45)	2.147 (54.53)	2.38 (60.45)	2.062 (52.37)	1.50 (38.10)	8.00 (3.6)

Dimensions are for layout purposes only. For tolerances contact Worcester Controls.
Metric dimensions are converted from standard English.

How To Order

1 1/2" 4 6 6 T SW

VALVE SIZE	PRODUCT SERIES	BODY, PIPE ENDS	BALL, STEM	SEAT	BODY SEAL	ENDS
1/4" 3/8" 1/2" 3/4" 1" 1 1/4" 1 1/2" 2"	4	1-Brass 4-Carbon Steel 6-316 S.S. A-Alloy 20	1-Brass* 4-Carbon Steel* 6-316 S.S. 7-Monel A-Alloy 20® C-Hastelloy C	B-Buna N-Neoprene T-TFE R-Reinforced TFE Y-Lubetal™ P-Polyfill® U-UHMWPE Use only one letter if body seal is to be same material as seat.	B-Buna N-Neoprene T-TFE E-EPR V-Viton® M-TFE Coated 316 S.S. U-UHMWPE	SE-**Screwed Pipe Ends** (NPT), Any Sch. Pipe† Carbon Steel Stainless Steel Brass Alloy 20 **Butt Weld Ends** BW1-Stainless Steel, Sch. 10 BW4-Carbon Steel, Sch. 40 BW5-Stainless Steel, Sch. 5 TE-**Solder/Sweat Ends** Brass-Type K, L, or M copper tube SW-**Socket Weld Ends,** Any Sch. Pipe† Carbon Steel Stainless Steel Alloy 20 SWO-**Socket Weld Ends, O.D Tube** Stainless Steel (not available in 1/4" and 3/8" sizes)

* Carbon Steel and Brass ball are hard chrome plated

Example: 1 1/2" Series 44 with 316 s.s. body ball and stem, TFE seats and seals, and socket weld ends.

†All IPS schedules of aluminum, stainless, carbon and alloy steel pipe, S.P.S. copper pipe and red brass pipe.

®Viton is a registered trademark of E.I. duPont.
™Lubetal is a trademark of Garlock.
®Polyfill is a registered trademark of Worcester Controls
®Alloy 20 is a registered trademark of Carpenter Technology

Externals: Externals, including handles, are normally constructed of zinc plated carbon steel. Handles are vinyl coated. When required, the body bolts nuts, follower, adjusting nut and handle nut are also available in stainless steel by special order, and come standard when ordering a 466 valve. Handle and stop plate are also standard in stainless steel when ordering a 4AA, or are available on special order with other combinations.

To order a Series 44 for use with:

34 or 36 actuators, prefix ordering code with "A". EXAMPLE: 1" A 446 PMSE
39 or 75 actuators, prefix ordering code with "B".

For additional information refer to

- **C-12 Corrosion Data** — For body, ball, stem and seat/seal material to media compatibility.
- **ASM Actuator Sizing Manual** — For seat material pressure/torque curves and actuator torque output charts.
- **PB 730 Series 75 Electric Actuators** — For detailed technical information.
- **PB 302 Series 39 Pneumatic Actuator** — For detailed technical information.
- **CV Ball Control Valve Brochure** — For standard ball control valves

Caution: Ball valves can retain pressurized media in the body cavity when closed. Use care when disassembling. Always open valve to relieve pressure prior to disassembly.

Due to continuous development of our product range, we reserve the right to alter the dimensions and information contained in this leaflet as required.

Distributed By:

Worcester Controls
A BTR Company

P.O. BOX 538, 33 LOCKE DRIVE
MARLBOROUGH, MA 01752
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(508) 481-4800 TELEX 6817563
FAX (508) 481-4454

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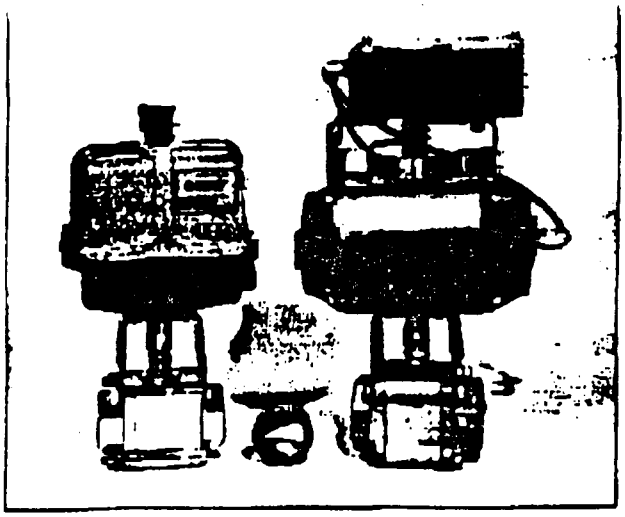
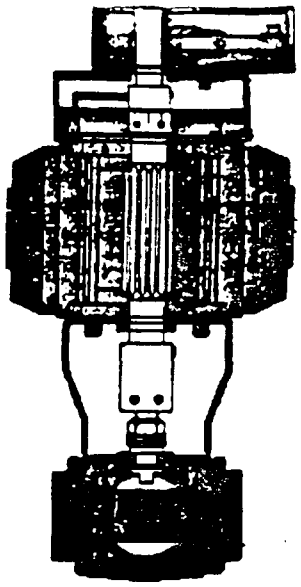
SCARBOROUGH, ONTARIO CANADA
M1S 4A5
(416) 298-1671 TELEX 065-25135
TELEFAX (416) 298-8330

Printed in U.S.A. 8/91 17M HF





AUTOMATION PNEUMATIC AND ELECTRIC CONTROLS

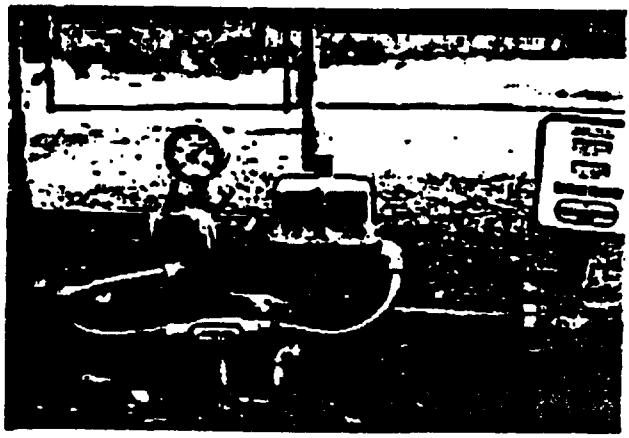
Easy automation is assured by our Series 39 pneumatic or Series 75 electric actuators. ***Both are backed by our exclusive two-year warranty.*** The Series 39 actuator is the toughest and most versatile rotary actuator available. Positioners (including electro-pneumatic) fail-safe feature, and mechanical and proximity limit switches provide ON/OFF or proportional control to your system with the feedback you require. Refer to Bulletin No. PB302.

Mount a Series 75 electric actuator and you have a high performance control valve package specifically designed for computer or PLC control. For proportional control, the Series 75 can work with digital or analog control loops. A variety of options allows you to select the performance criteria and feedback information you desire. The Series 75 is available with NEMA I, IV, VII or IX enclosures. Refer to Bulletin No. PB730.

Worcester valves represent a profound improvement over traditional globe and rotary valves that use heavy linear actuators, crank arms and associated linkage. ***Worcester has eliminated significant hysteresis and assured repeatability by powering through a solidly clamped, inline stem. All shafts operate together; actuator, positioner, valve stem. The design also eliminates side load on the valve stem because components (valve, actuator, positioner) are mounted symmetrically and weights are balanced. This extends valve stem seal life far beyond conventional valves.***

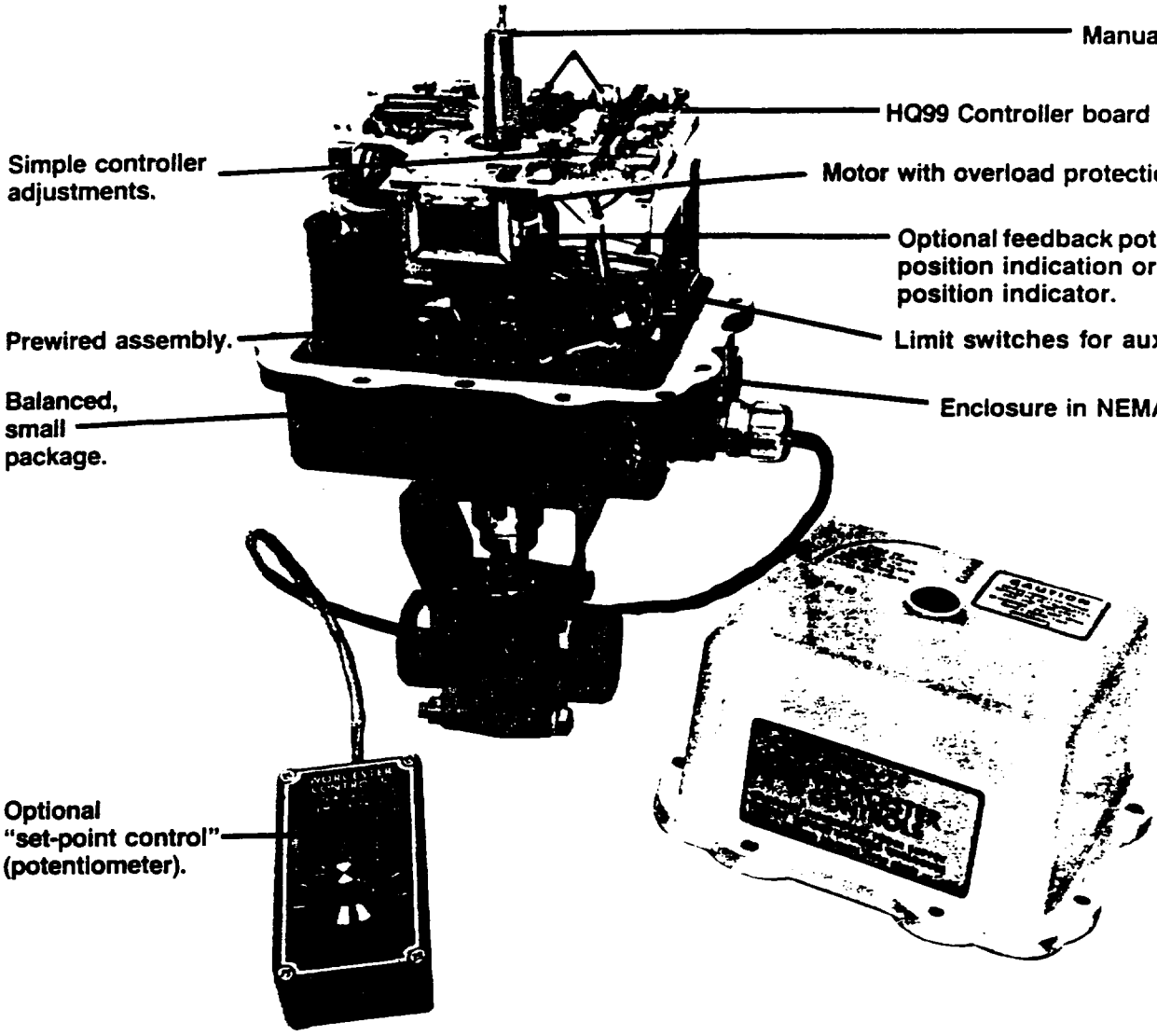
APPLICATIONS

- Steam Control
- Pressure Control
- Flow Control
- Temperature Control
- Level Control
- PH Control
- Low Flow Control
- High Abrasion Fluids
- Heat Transfer Fluids
- Slurry Control
- Paper Stock
- Water Flooding
- Oxygenation
- Food, Chemicals, Petroleum



The HQ99 Controller

Compact, reliable control for a variety of applications.



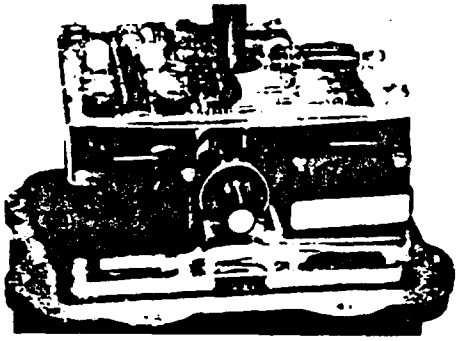
The new HQ99 solid state, electronic controller adds a new dimension to streamlining single loop process control. It is a cost effective solution to on-site control where there is no central control room for instruments and allows the set-point adjustment to be located where most convenient

Unique to the market, the HQ99 is a rugged, sensitive controller which when combined with an electric actuator, provides complete control function. The circuit board mounts inside the housing of the Worcester Controls Series 75 Electric Actuator and does not require its own special housing. The unit is protected by the actuators' NEMA IV and VII rated enclosures. Because the HQ99 is inside the control valve actuator, excess wiring is saved as well as the cost of a separate controller housing and the positioner function is eliminated, thus creating a simplified control loop.

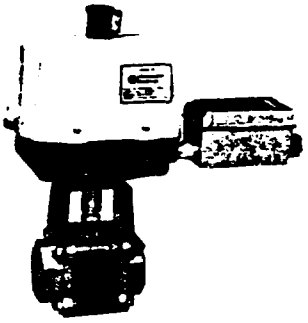
The HQ99, in conjunction with an internally or externally mounted set-point potentiometer unit, can regulate temperature, pressure, level, flow or any other process variable whose status can be transmitted via a variety of electric signals (see specifications). Solid state circuitry insures reliable, efficient service with energy savings.

The Series 75 Electric Actuator offers operational dependability and rugged compact design. It is available in six sizes offering torque outputs from 150-3000 in. lbs. A variety of NEMA enclosures and other electrical and mechanical options fit this actuator to the application. The HQ99 is optional equipment for the Series 75. A dual or single feedback potentiometer for remote position indication and limit switches for auxiliary circuitry are also available as options. Whether it is a hazardous, remote or difficult service, Worcester Controls can provide you with the process package you need for complete, accurate control.

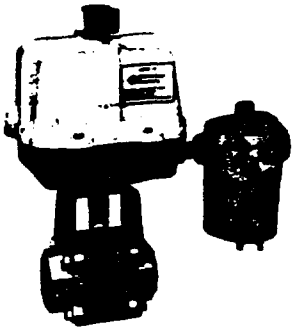
Principle of Operation



Internal Set Point Control

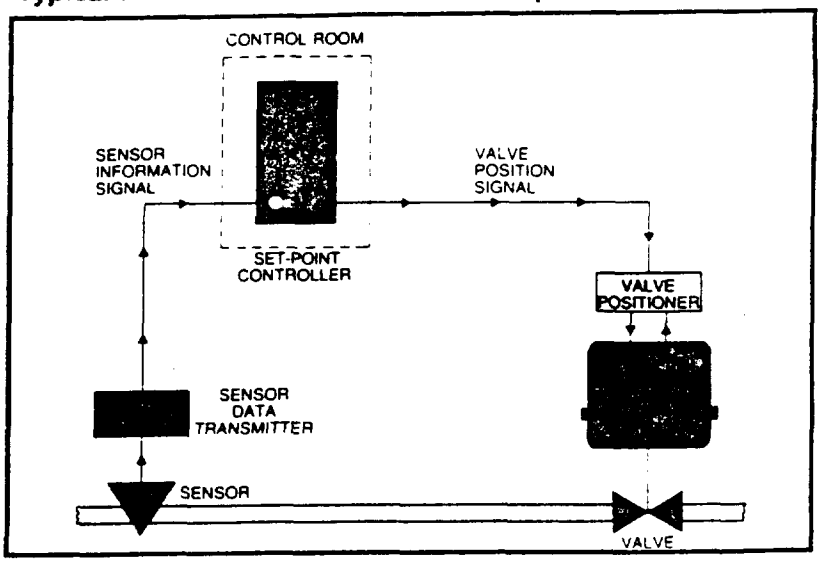


NEMA IV Externally Mounted Set Point Control

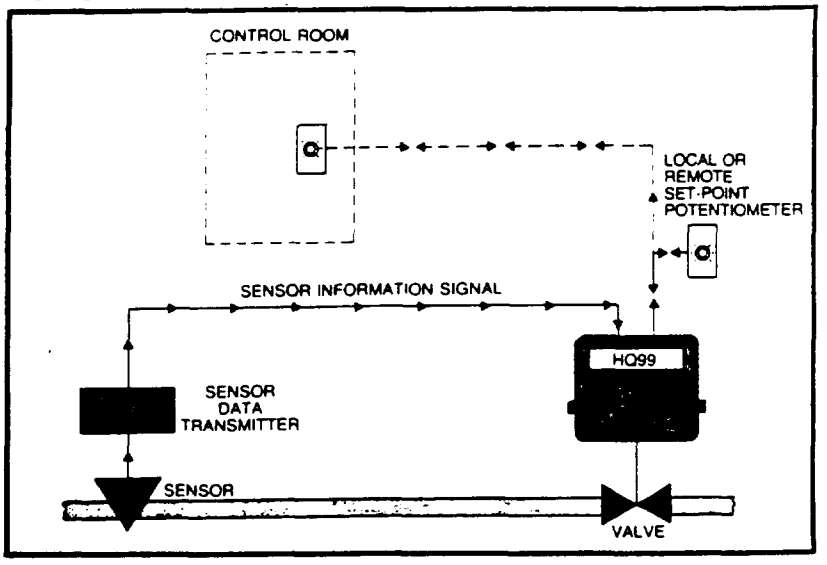


NEMA VII Externally Mounted Set Point Control

Typical Individual Process Control Loop



As Modified with Worcester's HQ99 Inside Actuator Housing



Control Loop Configuration

These two schematics illustrate the difference in process control loop configuration with and without Worcester's HQ99 Controller. The first schematic illustrates a typical process control loop. The signal from the sensor must pass through the set-point controller in the control room and the valve positioner before it finally reaches the valve and actuator package and affects valve position.

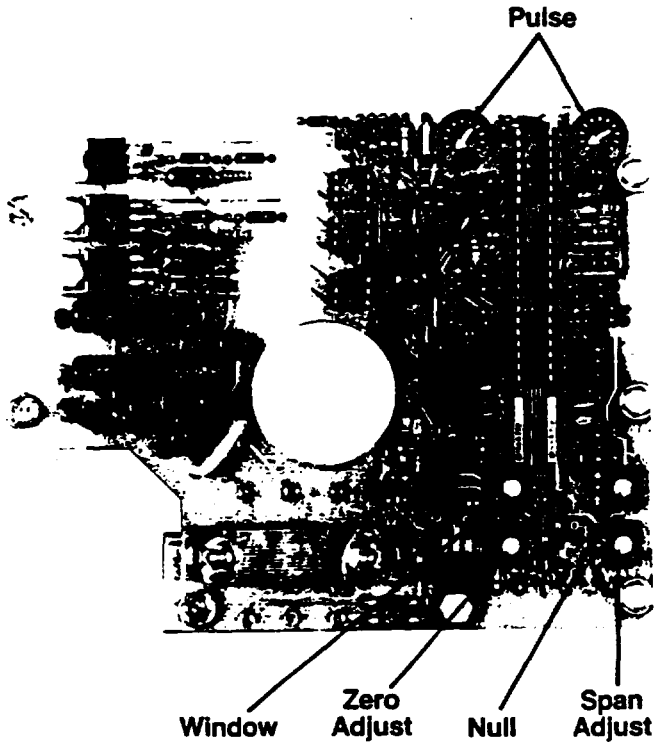
The second illustration shows the loop configuration simplicity gained by using an HQ99 Controller inside the actuator housing. The sensor signal follows a direct path to the HQ99, and the control loop is streamlined due to the combining of controller and positioner functions. The HQ99 Controller is completely protected inside the actuator's NEMA rated housing, and the set-point potentiometer may be located remotely or at the valve, or both, with a bypass switch for remote or local operation.

How It Works

The electric signal from the sensor (measuring element) is fed directly into the HQ99. The HQ99 reads this input signal, and compares it to the desired set-point of the process, which is controlled by a remote or local potentiometer. A set of limit points, one above and one below the set-point, define an electronic "window" for the HQ99. As long as the process variable's difference from the set-point falls within this window, the HQ99 will send electronic pulses to the actuator to correct the valve's position. If the deviance from the set-point falls outside the window, the HQ99 sends a continuous signal to the actuator, which will move the valve at a faster speed until the error falls within the window. At that point the HQ99 signal changes back to pulse mode until the set-point requirement is satisfied.

After the valve has completed its movement as instructed, the HQ99 observes a waiting period during which it compares the process variable's status to the set-point and makes sure no further movement is needed. This fast-slow-wait action allows quick yet stable response to process requirements.

HQ99 Adjustable Control



The HQ99 has several basic adjustable controls that allow flexibility in operation:

Zero Adjust:
Adjusts the HQ99 to match the minimum value of the sensor data transmitter's signal.

Span Adjust:
Adjusts the HQ99 to match the maximum value of the sensor data transmitter's signal.

Null:
Allows the increase or decrease of deadband about the set-point to inhibit spontaneous action of the controller by electrical noise.

Control Action Adjustment

These two controls adjust the manner in which the HQ99 responds to a change in signal.

Pulse Control:
A two-part control, which adjusts the on-time and off-time of the unit in the pulsing mode. This adjusts the effective speed of the unit while it is operating inside the "window." Both on and off times can be adjusted to fine tune the unit to match system requirements.

Window Control:
A control which adjusts the width of the "window." The window defines limits around the set-point at which the unit changes from slow to fast action. Outside the window, response is fast. The smaller the window, the faster the response. The larger the window, the more stable the unit.

Specifications

Input Signals:	Set-point 1K Pot. For others, consult factory	Sensor 4-20 mA 1-5 mA 10-5 mA 135 Ohms 1K Ohms
Operating Voltage:	120 VAC	
Independent Linearity:	0.5% of span	
Resolution:	0.5% of span	
Deadband:	0.4% of span	
Hysteresis:	0.5% of span	
Temperature:	-40°F (with heater and thermostat) to 115°F	
Set Point Potentiometer:	Standard Set Point Pot. (1K) Mounted inside the actuator at the factory.	
Duty Cycle:	Specify 75% or 100% duty cycle for actuator	

Power Consumption:	8 watts plus actuator power requirements
Characteristic:	Linear
Options:	Feedback potentiometer position indicator, 4-20 mA (single or dual) NEMA VII or IV external box for set point potentiometer.
Ordering Instructions: • Actuator Size • Power Supply •Set Point Location Internal External Optional NEMA IV external housing Optional NEMA VII external housing	When ordering, specify: • Sensor Signal • Standard Set Point Potentiometer (1K) or other (specify requirements)

Due to continuous development of our product range, we reserve the right to alter the dimensions and information contained in this leaflet as required.

Worcester Controls
A BTR Company

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FAX (508) 481-4454

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SCARBOROUGH, ONTARIO CANADA
M1S 4A5
(416) 298-1671 TELEX 065-25135
TELEFAX (416) 298-8330

Distributed by:

Printed in U.S.A. 3/90 10M WR

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-V6

NAME WET WELL SAMPLING VALVES

LOCATION WET WELL

MANUFACTURER

DISTRIBUTOR

DESCRIPTION 2-inch/1/2-inch steel tee fitting with 1/2-inch sampling ball valve

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X10

NAME WET WELL CHAMBER COVER

LOCATION

MANUFACTURER Bilco

DISTRIBUTOR

DESCRIPTION Bilco pit door, size 2'-6" x 3'-0" Model O-3,lockable

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X7

NAME WET WELL UNIONS

LOCATION WET WELL

MANUFACTURER

DISTRIBUTOR

DESCRIPTION 2-inch, steel

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X11

NAME ACCESS MANHOLE FLOAT SWITCHES

LOCATION PIPE AND MEDIA DRAIN ACCESS MANHOLES

MANUFACTURER Magnatek Controls, B/W Controls

DISTRIBUTOR Nelcor Inc.
5169 Wooster Pike
Cincinnati, Ohio 45226
513-871-2816

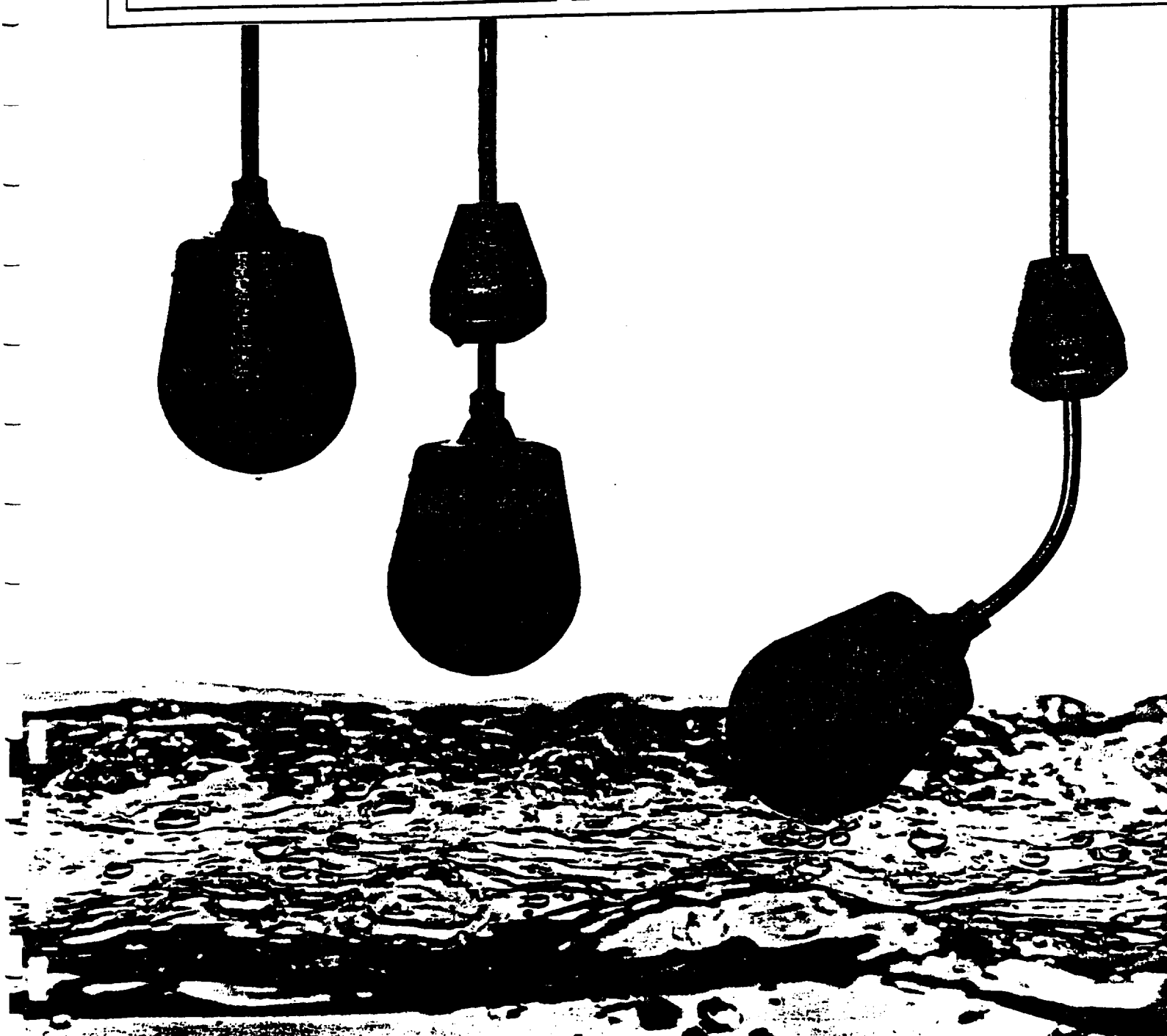
DESCRIPTION Liquid level float switch model 7010 complete with cord grip and wall mounted bracket

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

LIQUID LEVEL FLOAT SWITCHES



- Hermetically Sealed Mercury Switch Provides High Reliability
- Low Cost—Easy To Install
- Ideal For Sump Pumps And Sewage Control
- Chemically Resistant Polypropylene Casing and PVC Cord
- N.O., N.C. or SPDT Contacts Available
- Switch Ratings Up to ½ HP

MagneTek Controls
B/W Controls
1060 N. Crooks Rd., Clawson, Michigan 48017-1097
Phone: 313 435 0700 EasyLink: 628 32092
Fax: 313 280 1544 Telex: 23 5359

LIQUID LEVEL FLOAT SWITCHES

MagneTek Controls B/W Controls

Float:	Chemically Stable Polypropylene
Float Dimensions:	Length 4.0" Diameter 3.5" Strain Relief 1.0"
Cord:	Multi-conductor PVC
Cord Size:	16/3 for S.P.D.T. 16/2 for either N.O. or N.C. Operation
Cord Length:	20 ft. unless otherwise specified
Operating Temperature:	32°F to 160°F Materials are rated to 221°F
Operating Pressure:	Pressure tested to 60 feet of water (26 psi.)

Switch Ratings:

Switch Code		Running Current (Amps) at 120 VAC	Running Current (Amps) at 240 VAC
Wide Angle	A	20.0	15.0
Narrow Angle	G L	1.0 15.0	.7 11.0
Narrow Angle S.P.D.T.	W	15.0	11.0

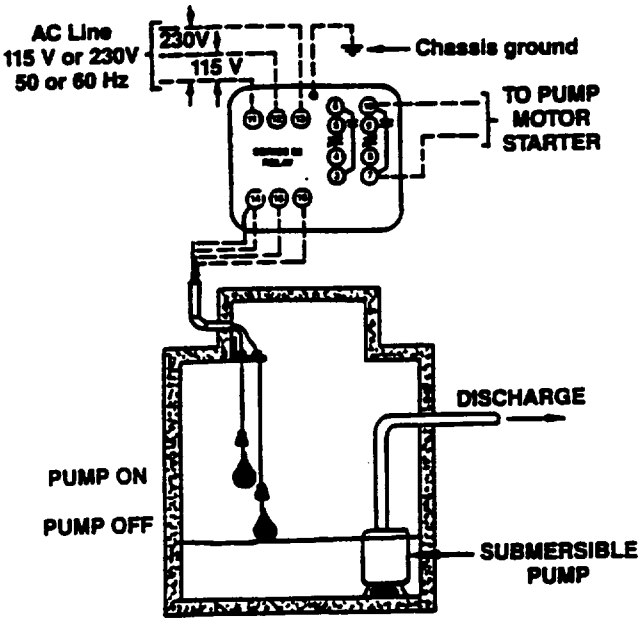
DESCRIPTION

The B|W Float Switches are mercury-switch actuated liquid level controls, designed to operate pumps, valves, chlorinators, multiple pump alternators, relays, contactors, alarms and similar equipment for industrial and commercial use.

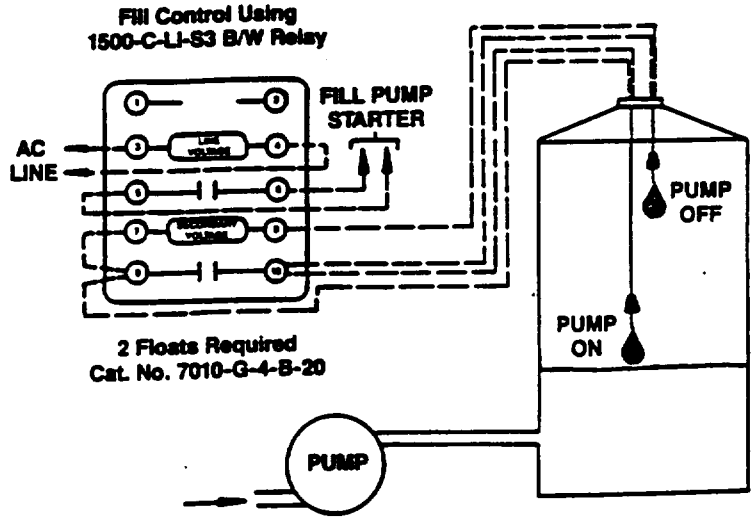
A hermetically sealed, axially non-position sensitive mercury switch inside the polypropylene float, provides a reliable long lasting level control suitable for most liquid environments up to 160°F.

The B|W Float Switches provides an ideal pilot device for the control of all B|W Control relays and control panels. The polypropylene float, Nitrile Gasket, PVC cable and hermetically sealed mercury switch, provides an economical liquid level solution for controlling sewage, effluent, many chemical solutions and in other hostile environments containing oil, grease or other similar industrial and municipal wastes where dependable liquid level control is essential.

Pump Down Control Using Intrinsically Safe Relay Model 5300-S-F1
2 Floats Required:
Cat. No. 7010-G-4-A-20



Fill Control Using 1500-C-LI-S3 B/W Relay



2 Floats Required
Cat. No. 7010-G-4-B-20

CATALOG NUMBERING SYSTEM

7010 — G — 4 — A — 20

Catalog Section

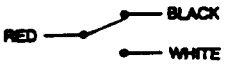
Float Size	
4	3½" Diameter

Contact Arrangement	
A	N.O. — Normally open for Pump Down
B	N.C. — Normally closed for Pump Up
*C	S.P.D.T. — Single Pole Double Throw for both pump up or pump down

*Applies only in "W" switch types.

	Switch Type			
	Running Current (Amps) 120 VAC	Running Current (Amps) 240 VAC	Operating Angle	List Price
	Wide Angle N.O. or N.C.			
A	20.0	15.0	120°	$82.00
	Narrow Angle N.O. or N.C.			
G	1.0	0.7	15°	$71.50
L	15.0	11.0	10°	$78.50
	Narrow Angle SPDT			
W	15.0	11.0	18°	$110.00

S.P.D.T. Contact Configuration



Note: When using B|W relays, specify Type G Switch. Switches stocked in 20 foot lengths.

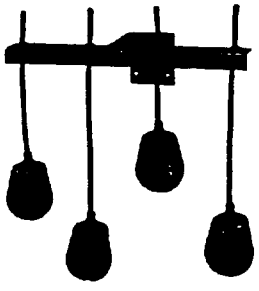
	Cord Length	List Price
20	20 ft. is standard	No Addition
	Specify other special length	Add $1.25/ft.** Over 20 ft.

**Special lengths must be ordered in quantities of 50 units or more.

ACCESSORIES

Float Switch Weight (20 ounces)
Part No. 12-085000
List Price $12.00

½" Cord Grip for Single Float Switch Part No. 12-084900
List Price $12.00



Wall Mount Bracket For up to 4 Float Switches
Part No. 12-085100
List Price $29.00

Wall Mount Bracket For Single Float Switch
Part No. 12-085200
List Price $9.50

EQUIPMENT SPECIFICATION FORM

SUMMIT NATIONAL SITE

EQUIPMENT NO. SS1-X12

NAME FORCEMAIN

LOCATION BETWEEN EXTRACTION WELL AND MANHOLES AND BETWEEN WET WELL AND TREATMENT BUILDING

MANUFACTURER

DISTRIBUTOR

DESCRIPTION High density polyethylene (HDPE)

MAINTENANCE

COMPONENT PARTS

SPARE PARTS

B

APPENDIX B

ALLOWABLE WET WELL SHUTDOWN PERIOD

M E M O

TO: Mike Mateyk REFERENCE NO. 2372-20/af

FROM: Richard Murphy

DATE: August 26, 1992

RE: Allowable Wet Well Shut-Down Period
Summit National Superfund Site

Introduction

The groundwater containment system for the Summit National Superfund Site consists of an overburden pipe and media drain and a series of six bedrock extraction wells (refer to Drawing D-1). The extraction wells are situated along the drain alignment and discharge directly to the drain. Groundwater entering the drain, from both bedrock and overburden sources, flows to the wet well under the influence of gravity. The water level at the wet well is maintained at a low level by pumping, with discharge going to the groundwater treatment system.

In order to perform maintenance on the treatment system, it may be necessary to temporarily halt the extraction of water from the drain. Cessation of groundwater extraction from the drain would allow the water level to rise in the drain and the surrounding overburden. At some point in time the water levels would recover to a level which is sufficient to induce contaminated groundwater from the site to flow beyond the range of influence of the drain when pumping resumes. If groundwater extraction is discontinued beyond the time at which contaminated groundwater has travelled to the limit of the drain's zone of capture, off-site contamination will occur.

In order to plan for shut-down of the treatment system without off-site migration of contaminated groundwater it is necessary to predict how long the wet well can be shut-down without losing hydraulic containment in the overburden. This document presents an evaluation of the allowable wet well shut-down period.

Methodology

The determination of the allowable shut-down period for the wet well requires the estimation of two quantities. First, the rate of groundwater flow into the drain from both overburden and bedrock sources. Second, the available volume of groundwater storage in the overburden in the vicinity of the drain. The allowable

shut-down period is equal to the quotient of the storage volume divided by the flow rate.

The flow rate into the drain is equal to the sum of the flows from the overburden and bedrock zones. In order to ensure a conservatively high estimate of the combined flow to the drain, the steady-state flow rates from both zones are utilized.

The predicted total flow from the bedrock wells is six gpm (6 wells x 1 gpm/well), as presented in the 30% Design. It is assumed that these wells would continue to operate during a period of wet well shut-down.

The predicted total flow into the drain from the overburden is 36 gpm (Design Criteria Document). This flow is comprised of 26 gpm of baseflow and 10 gpm of infiltration. The use of 26 gpm for baseflow is conservative because it incorporates the following three assumptions.

- The flow entering the off-site side of the drain is equal to that entering the on-site side;
- The flow rate into the drain is uniform along the entire length of the drain; and
- The flow into the drain does not vary as the water level rises in the drain during wet well shut-down.

The hydraulic head drop inducing flow into the off-site side of the drain is expected to be less than 50 percent of that on the on-site side. Thus the flow entering the off-site side is expected to be less than the estimated value.

The bottom elevation of the drain rises in both directions away from the wet well. The saturated thickness contributing flow to the drain at the edge of the drain's zone of influence is assumed to be 26.5 feet, but actually reduces to approximately 15 and 10 feet at the west and east extremities of the drain, respectively. Thus the average flow into the drain along its length may be overestimated.

Once the wet well is shut down, the water level in the drain will rise. This increased head in the drain will reduce the hydraulic gradient towards the drain and hence reduce the flow into the drain from the overburden.

The total flow into the drain during a wet well shut down is therefore conservatively estimated to be equal to 42 gpm (36 gpm from the overburden plus 6 gpm from the bedrock wells).

The available volume of groundwater storage is proportional to the allowable water recovery level in the drain. The higher the water level can be allowed to recover without loss of hydraulic containment, the greater the duration of the allowable shut-down of the wet well. For the purpose of this evaluation if was conservatively assumed that the water level could only recover to the static water level at the southern limit of the drain's zone of influence (200 feet beyond the drain) without a loss of hydraulic containment.

In the RI, this "downgradient" water level was determined to be approximately 1072 feet AMSL based on an observed water level of 1062 feet AMSL at MW-19 in September of 1986. Evaluation of more recent water level data (October and December of 1991) presented in the Technical Memorandum: Groundwater and Surface Water Characterization (CRA, 1992 - Table TM4-1) and the borehole log for MW-19 indicate that a more representative water level at MW-19 is 1072 feet AMSL. The corresponding down gradient water level is approximately 1078 feet AMSL (see Figure 4-6).

Examination of Drawing D-3 reveals that allowing the water level in the drain to rise to 1078 feet would result in saturation of the backfill material along almost the entire drain length. It was felt that this water level was to high given the uncertainty with respect to off-site water levels when the drain is in operation. The allowable shut-down period for the wet well was evaluated for allowable water levels ranging from 1070 to 1076 feet AMSL.

The volume of storage available for a given water recovery level is equal to the volume of porous media to be occupied by the increased water levels multiplied by the available porosity (total porosity minus initial moisture content).

The volume of porous media is estimated by calculating the cross-sectional areas represented in Figure A.1, and integrating along the length of drain which lies below the water recovery level. This method of calculation incorporates the following assumptions.

- The rising water table maintains a steady-state shaped profile perpendicular to the drain alignment;
- The water level varies linearly parallel to the drain alignment; and
- The top of bedrock surface lies parallel to the drain elevation along the drain alignment and is horizontal in the direction perpendicular to the drain alignment.

Further assumptions that were made in this analysis include:

- The water level in the drain prior to wet well shut-down is coincident with the top of the bedding material in the drain (this probably overestimates the initial water level and hence results in underestimation of the available storage volume);

- The drain slope east of the wet well is constant at 4.3 % until the top of bedding material elevation reaches 1076 feet AMSL (this results in an underestimation of the available storage volume);

- The available porosity is equal to 0.2 (i.e. 20 percent of the total porous medium volume); and

- The drain's zone of influence is constant at 200 feet.

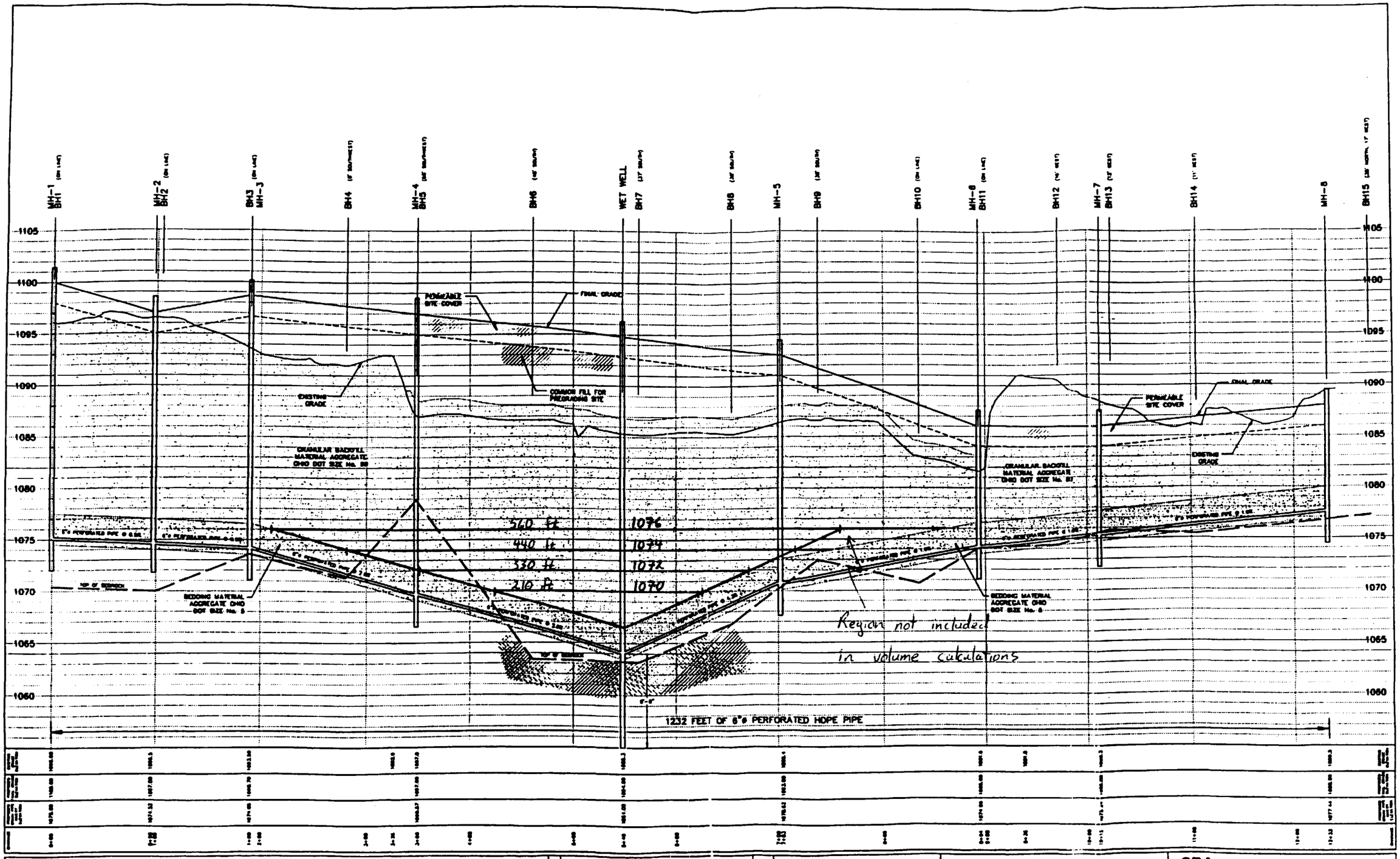
The details of allowable storage volume and shut-down period calculations are presented as Attachment A.

The allowable shut-down time is estimated to range from one to nine days for water recovery levels of 1070 to 1076 feet AMSL, as presented below.

Allowable Water Recover Level, Z_2 (feet AMSL)	*Extent of Drain Below Z_2, E (feet)*	*Water Storage Available, S (gallons)*	*Allowable Shut-Down Time, T (days)*
1070	210	70,850	1.2
1072	330	177,448	2.9
1074	440	328,373	5.4
1076	560	539,276	8.9

Note: T=S/Q, where Q=42 gpm

An allowable water recovery level of 1072 to 1074 feet AMSL is considered to be a reasonable estimate of what may be expected when the drain is in operation. The allowable shut-down period for the wet well is therefore predicted to be approximately three to five days. This estimate is considered to be conservative with respect to what may actually be experienced in the field.



Assumed Water Level in Drain prior to Filling

1070 Allowable Water Recovery Level (Z_3)

210 ft Extent of Drain below Z_3

1	JOB DESIGN SUBMITTAL	JUNE 1, 1992	JH
No.	Revisions	Date	Initial

Approved

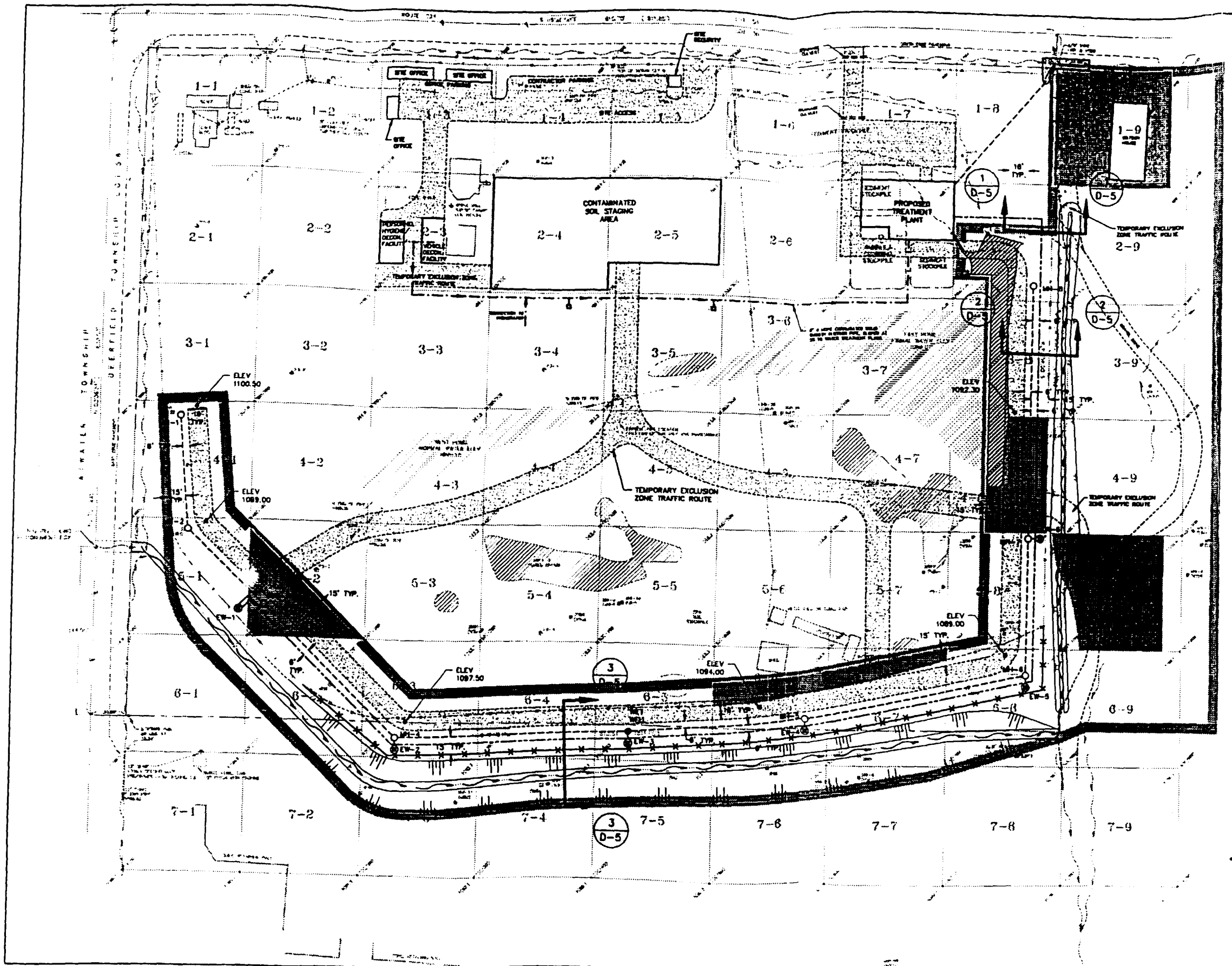
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO

GROUNDWATER EXTRACTION SYSTEM

PIPE & MEDIA DRAIN PROFILE

CRA
COMSTOCK-ROVERS & ASSOCIATES

Drawn by JHV | Scale N/A | Date MARCH 1992 | File No. 10 (PROF) | Revision 1
Designed by AJB
Checked by RMS
Field Book | Project No. 2372 | Drawing No. D-3



0 30 60ft

SOURCE
DEERFIELD TOWNSHIP, LOT 56
PORTAGE COUNTY, OHIO

LEGEND

- PROPERTY BOUNDARY
- GRADE CONTOUR
- CHAIN LINK FENCE
- OVERHEAD POWERLINES
- CULVERT
- DRAINAGE PATH/DITCH/SWALE
- POND
- AREA OF BURIED DRUMS
- LIGHT POLE
- POWER POLE
- 3-9 GRID SQUARE IDENTIFICATION
- GRID SYSTEM
  1091.2 EXISTING GRADE ELEVATION
  6/200 SOUTH/EAST SITE COORDINATE SYSTEM
- PIEZOMETER LOCATION (ALL WATER TABLE UNIT)
- MONITORING WELL LOCATION
  (WTU) WATER TABLE UNIT
  (LIU) UPPER INTERMEDIATE UNIT
  (LIU) LOWER INTERMEDIATE UNIT
  (USU) UPPER SHARON UNIT
- SOIL BORING LOCATION
- EXISTING FENCE TO BE REMOVED
- NEW RELOCATED FENCE
- PIPE AND MEDIA DRAIN (PERFORATED HDPE PIPE)
- MH-2 ACCESS MANHOLE
- WET WELL WET WELL
- FORCEMAIN/ELECTRICAL (POWER SUPPLY) CONDUIT/ELECTRICAL CONTROLS CONDUIT
- EXTRACTION WELL
- ACCESS GRAVEL ROADS
- EXCAVATE TWO FEET OF SOIL AND PLACE AT THE CONTAMINATED SOIL STAGING AREA
- LIMIT OF WORK AREA
- PROPOSED DITCH
- DISPLACE TWO FEET OF SEDIMENT OR EXCAVATE AND PLACE AT THE CONTAMINATED SOIL STAGING AREA

No	Revision	Date	Initial
1	30% DESIGN SUBMITTAL	JUNE 1, 1992	JM

Approved

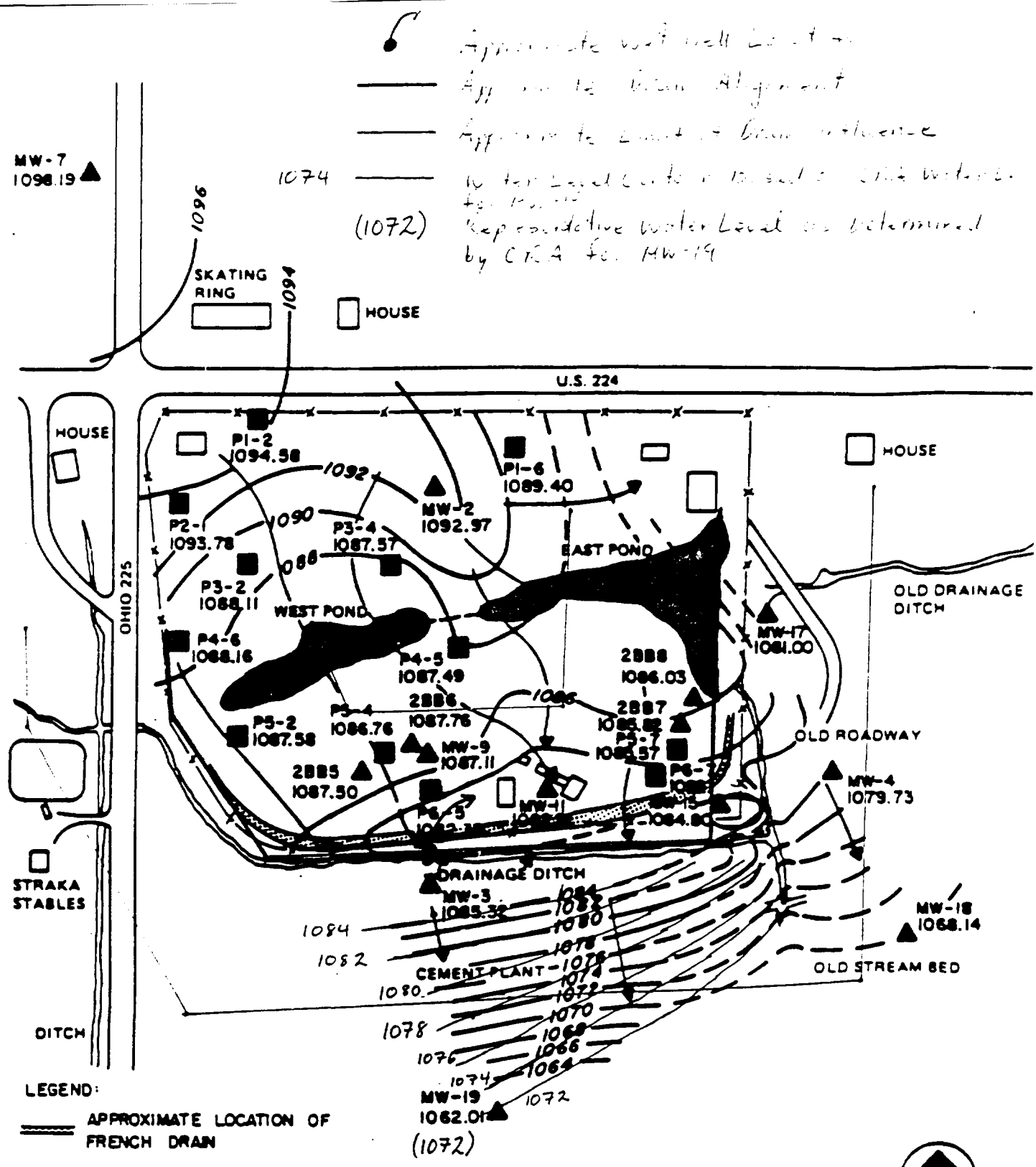
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO

GROUNDWATER EXTRACTION SYSTEM

SITE WORK

CRA
CONESTOGA-ROVERS & ASSOCIATES

Drawn by R.B.B.	Scale 1"=40'	Date MARCH 1992	File No. 9 (P-03)	Rev. No. 1
Designed by A.M.				
Checked by J.M.	Plate Scale	Project No. 2372	Drawing No. D-1	



NOTE. All locations of structures and physical features approximate.

SOURCE Modified from USEPA.

FIGURE 4-6
WATER-TABLE MAP
FOR SEPTEMBER 1986
SUMMIT NATIONAL RI

ATTACHMENT A

Calculations

CRA
CONESTOGA-ROVERS & ASSOCIATES

PROJECT 2372-20 BY JKM

SUBJECT

DATE A-1 JC

Water Level - Perpendicular to Drain Alignment

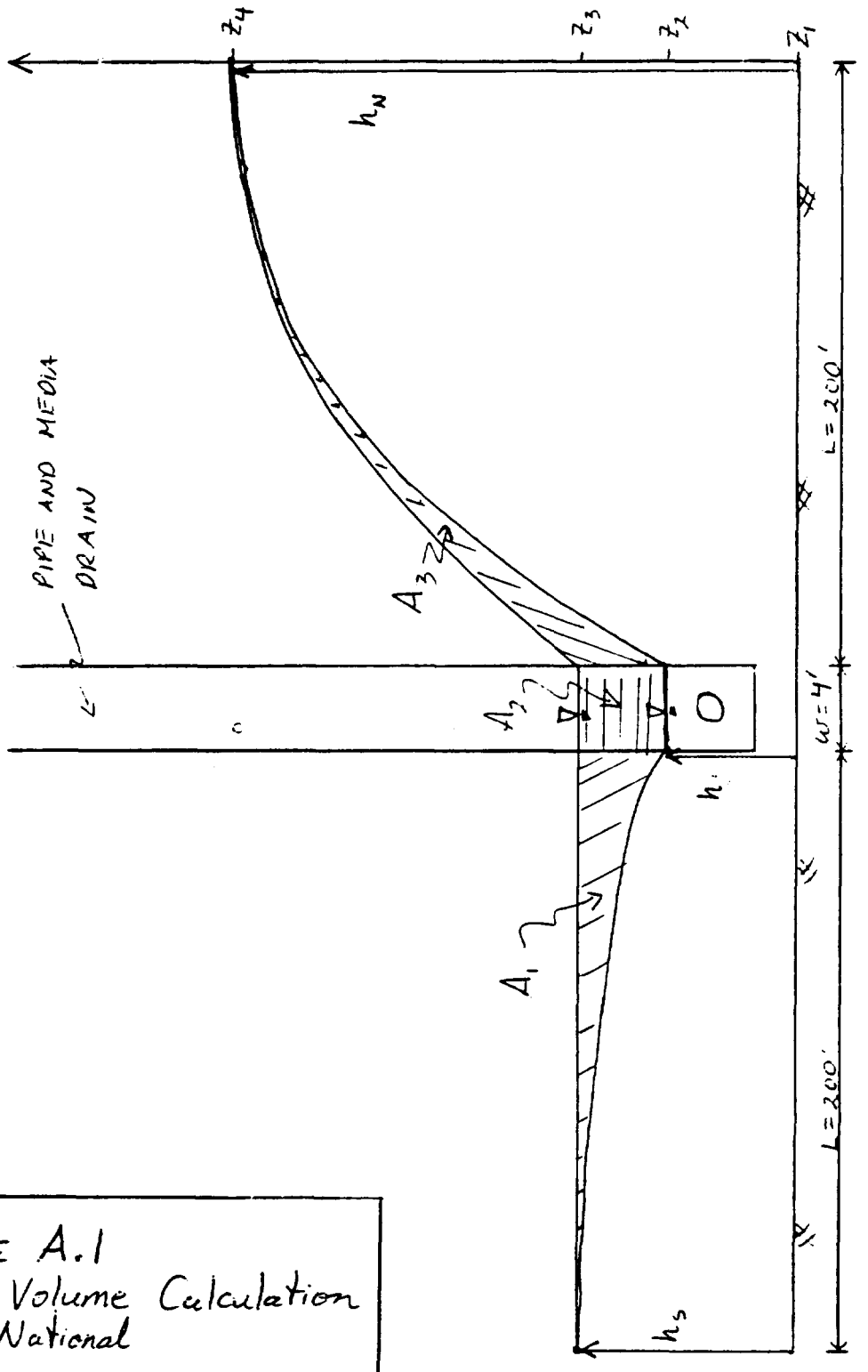
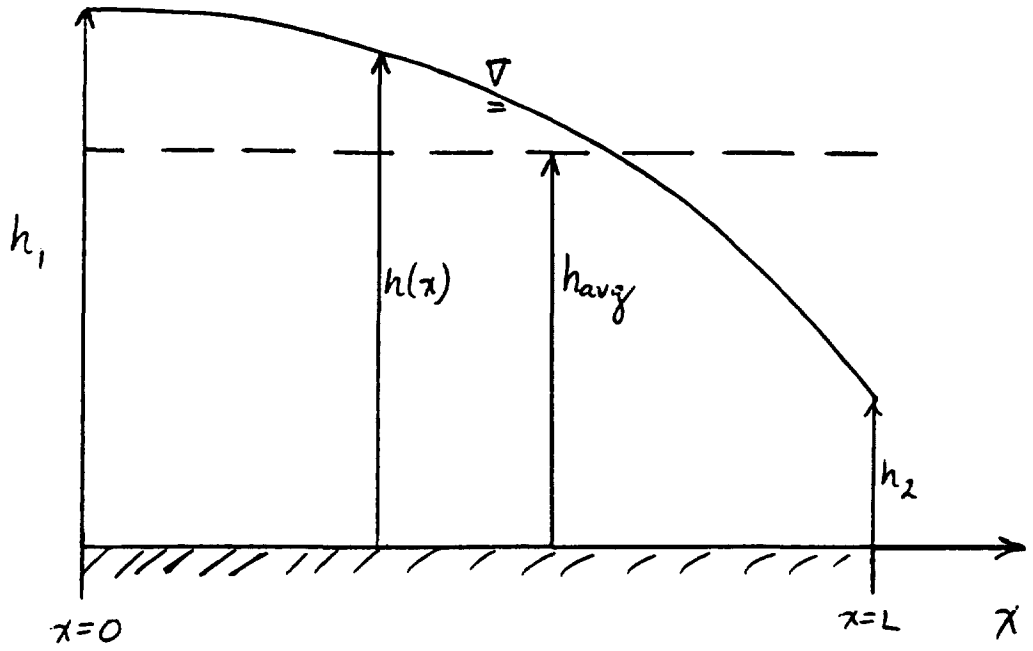


FIGURE A.1
Storage Volume Calculation
Summit National

Water Level in vicinity of drain



$$h(x) = \sqrt{h_1^2 - (h_1^2 - h_2^2)\frac{x}{L}}$$; [Harr, M.E., Groundwater and Seepage, McGraw-Hill, New York, NY, 1962, page 42, Equation 2-2(3).]

$$h_{avg} = \frac{1}{L}\int_0^L h(x)\,dx$$

substituting: $a = -(h_1^2 - h_2^2)/L$, $b = h_1^2$

$$h_{avg} = \frac{1}{L}\int_0^L \sqrt{ax + b}\,dx$$

from Grossman, S.I., CALCULUS, Academic Press, 1984
page A60 - Standard Form #41

$$h_{avg} = \frac{1}{L}\left[\frac{2\sqrt{(ax+b)^3}}{3a}\right]_0^L$$

back substituting : a, b

$$h_{avg} = \frac{2}{3L}\left[\frac{(h_1^2 - (h_1^2 - h_2^2)\frac{x}{L})^{3/2}}{-(h_1^2 - h_2^2)/L}\right]_0^L$$

$$h_{avg} = \frac{2}{3L}\left\{\frac{\left[(h_1^2 - (h_1^2 - h_2^2))^{3/2}\right] - \left[(h_1^2)^{3/2}\right]}{-(h_1^2 - h_2^2)/L}\right\}$$

$$h_{avg}(h_1, h_2) = \frac{2}{3}\left(\frac{h_1^3 - h_2^3}{h_1^2 - h_2^2}\right)$$

$$A_1 = (h_s - h_{avg}(h_s, h_d)) * L$$

$$A_2 = (h_s - h_d) * w \quad ; w = \text{drain width perpendicular to flow}$$

$$A_3 = (h_{avg}(h_N, h_s) - h_{avg}(h_N, h_d)) * L$$

Groundwater Storage Volume, S

$S = \forall * \eta_a$; $\forall$ = Volume of porous medium
η_a = Available porosity
(total porosity - occupied porosity)

$\forall = (A_1 + A_2 + A_3)_{avg} * E$; E = Extent (length) of drain surrounding WET WELL below allowable recovery level

$(A_1 + A_2 + A_3)_{avg}$ = Average storage area along E

$$\forall = \left[\frac{(A_1 + A_2 + A_3)_{\substack{WET \\ WELL}} + \textcircled{1}}{2}\right] E_{WEST} + \left[\frac{(A_1 + A_2 + A_3)_{\substack{WET \\ WELL}} + \textcircled{1}}{2}\right] * E_{EAST}$$

$$\forall = (A_1 + A_2 + A_3)_{\substack{WET \\ WELL}} * (E_{WEST} + E_{EAST})/2$$

$$\therefore \boxed{S = (A_1 + A_2 + A_3)_{\substack{WET \\ WELL}} * E * \eta_a / 2}$$

Filling Time, T

$T = S/Q$; Q = inflow rate to trench

Example Calculation:

given:

$z_1 = 1063.5$ ft AMSL
$z_2 = 1066.5$ ft AMSL
$z_3 = 1070.0$ ft AMSL
$z_4 = 1090.0$ ft AMSL

$L = 200$ ft
$w = 4$ ft
$E = 210$ ft
$\eta_a = 0.20$
$Q = 42.0$ gpm

$h_d = z_2 - z_1 = 3$ ft
$h_s = z_3 - z_1 = 6.5$ ft
$h_N = z_4 - z_1 = 26.5$ ft

$$A_1 = (h_s - h_{avg}(h_s, h_d)) * L$$

$$h_{avg}(h_s, h_d) = \frac{2}{3}\left(\frac{h_s^3 - h_d^3}{h_s^2 - h_d^2}\right) = \frac{2}{3}\left(\frac{6.5^3 - 3^3}{6.5^2 - 3^2}\right) = 4.96 \text{ ft}$$

$$A_1 = (6.5 - 4.96) * 200 = \underline{307 \text{ ft}^2}$$

$$A_2 = (h_s - h_d) * w = (6.5 - 3) * 4 = \underline{14 \text{ ft}^2}$$

$$A_3 = (h_{avg}(h_N, h_s) - h_{avg}(h_N, h_d)) * L$$

$$h_{avg}(h_N, h_s) = \frac{2}{3}\left(\frac{h_N^3 - h_s^3}{h_N^2 - h_s^2}\right) = \frac{2}{3}\left(\frac{26.5^3 - 6.5^3}{26.5^2 - 6.5^2}\right) = 18.52 \text{ ft}$$

$$h_{avg}(h_N, h_d) = \frac{2}{3}\left(\frac{h_N^3 - h_d^3}{h_N^2 - h_d^2}\right) = \frac{2}{3}\left(\frac{26.5^3 - 3^3}{26.5^2 - 3^2}\right) = 17.87 \text{ ft}$$

$$A_3 = (18.52 - 17.87) * 200 = \underline{130 \text{ ft}^2}$$

$$S = (A_1 + A_2 + A_3)_{\substack{WET \\ WELL}} * E * \eta_a / 2$$

$$= (307 + 14 + 130) * 210 * 0.2 / 2$$

$S = 9324\ ft^3$ water

$S = 70\,843$ gallons water

$T = S/Q = 70\,843$ gallons $/ 42$ gpm

$= 1687$ minutes

$T = 1.2$ days ←

Calculation of Drain Storage Capacity and Fill Time 08/25/92 jrm
Overburden & IA-BR Groundwater Collection 2372
Summit National

h_avg=-2*((h1^2-(h1^2-h2^2))^1.5 -h1^3)/(3*(h1^2-h2^2))
[jrm 18/8/92]

A1: ==> base = 1063.5
----> elev1 = 1070 ----> E = 210
==> elev2 = 1066.5
h1= 6.5 ==> eff por = 0.2
h2= 3
h_avg = 4.964912
l_avg = 1.535087
A1 = 307.0

A2: A2 = 14.0

A3: Z1... Z2...
base = 1063.5 base = 1063.5
==> elev1 = 1090 elev1 = 1090
elev2 = 1066.5 elev2 = 1070
h1= 26.5 h1= 26.5
h2= 3 h2= 6.5
h_avg = 17.87005 h_avg = 18.52020

A3 = 130.0

A_tot = 451 ft^3/ft

V_tot = 47360 ft^3 soil

S_tot = 9472 ft^3 h2o
70850 gal h2o

flow(gpm) 42

TIME (DAYS) 1.2 <======== Allowable Shut-Down Period

Calculation of Drain Storage Capacity and Fill Time 08/25/92 jrm
Overburden & IA-BR Groundwater Collection 2372
Summit National

h_avg=-2*((h1^2-(h1^2-h2^2))^1.5 -h1^3)/(3*(h1^2-h2^2))
[jrm 18/8/92]

A1: ==> base = 1063.5
----> elev1 = 1072 ----> E = 330
==> elev2 = 1066.5
h1= 8.5 ==> eff por = 0.2
h2= 3
h_avg = 6.188405
l_avg = 2.311594
A1 = 462.3

A2: A2 = 22.0

A3: Z1... Z2...

	Z1...	Z2...
base =	1063.5	1063.5
==> elev1 =	1090	1090
elev2 =	1066.5	1072
h1=	26.5	26.5
h2=	3	8.5
h_avg =	17.87005	19.04285

A3 = 234.6

A_tot = 719 ft^3/ft

V_tot = 118615 ft^3 soil

S_tot = 23723 ft^3 h2o
177448 gal h2o

flow(gpm) 42

TIME (DAYS) 2.9 <======== Allowable Shut-Down Period

Calculation of Drain Storage Capacity and Fill Time 08/25/92 jrm
Overburden & IA-BR Groundwater Collection 2372
Summit National

h_avg=-2*((h1^2-(h1^2-h2^2))^1.5 -h1^3)/(3*(h1^2-h2^2))
[jrm 18/8/92]

A1: ==> base = 1063.5
----> elev1 = 1074 ----> E = 440
==> elev2 = 1066.5
h1= 10.5 ==> eff por = 0.2
h2= 3
h_avg = 7.444444
l_avg = 3.055555
A1 = 611.1

A2: A2 = 30.0

A3: Z1... Z2...
base = 1063.5 base = 1063.5
==> elev1 = 1090 elev1 = 1090
elev2 = 1066.5 elev2 = 1074
h1= 26.5 h1= 26.5
h2= 3 h2= 10.5
h_avg = 17.87005 h_avg = 19.65315

A3 = 356.6

A_tot = 998 ft^3/ft

V_tot = 219501 ft^3 soil

S_tot = 43900 ft^3 h2o
328373 gal h2o

flow(gpm) 42

TIME (DAYS) 5.4 <======== Allowable Shut-Down Period

Calculation of Drain Storage Capacity and Fill Time 08/25/92 jrm
Overburden & IA-BR Groundwater Collection 2372
Summit National

h_avg=-2*((h1^2-(h1^2-h2^2))^1.5 -h1^3)/(3*(h1^2-h2^2))
[jrm 18/8/92]

A1: ==> base = 1063.5
----> elev1 = 1076 ----> E = 560
==> elev2 = 1066.5
h1= 12.5 ==> eff por = 0.2
h2= 3
h_avg = 8.720430
l_avg = 3.779569
A1 = 755.9

A2: A2 = 38.0

A3: Z1... Z2...
base = 1063.5 base = 1063.5
==> elev1 = 1090 elev1 = 1090
elev2 = 1066.5 elev2 = 1076
h1= 26.5 h1= 26.5
h2= 3 h2= 12.5
h_avg = 17.87005 h_avg = 20.33760

A3 = 493.5

A_tot = 1287 ft^3/ft

V_tot = 360479 ft^3 soil

S_tot = 72096 ft^3 h2o
539276 gal h2o

flow(gpm) 42

TIME (DAYS) 8.9 <======== Allowable Shut-Down Period

C

APPENDIX C

GEOTECHNICAL INVESTIGATION REPORT

GEOTECHNICAL ENGINEERING STUDY
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP
PORTAGE COUNTY, OHIO

Huntingdon
Consulting Engineers Environmental Scientists

Empire Soils Investigations, Inc., Division

Huntingdon

Empire Soils Investigations, Inc., Division

GEOTECHNICAL ENGINEERING STUDY
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP
PORTAGE COUNTY, OHIO

Prepared for:

Conestoga-Rovers & Associates Limited
651 Colby Drive
Waterloo, Ontario, Canada
N2V 1C2

Attention: Mr. Steve Whillier

BTA-92-205
October 07, 1992

TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING STUDY
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP
PORTAGE COUNTY, OHIO

I. INTRODUCTION

This report presents the results of the subsurface exploration and geotechnical engineering evaluations performed by Empire Soils Investigations, Inc. (Empire) for design and construction of a ground water treatment building at the Summit National Superfund Site in Deerfield Township of Portage County in Ohio. In addition, this report presents the results of subsurface exploration and laboratory testing of soils for the temporary treatment facility and waste consolidation area as well as the testing of surficial soils in other areas. Mr. Steve Whillier of Conestoga-Rovers & Associates authorized Empire to provide the services as indicated in the letter of September 2, 1992. We have performed these services in general accordance with our proposal PD-92-191 dated September 1, 1992. This report specifically addresses the following topics:

- o A brief description of the site and the proposed construction.
- o A summary of the subsurface exploration program, which included drilling of five (5) test borings, and soil sampling, moisture content and in-place density tests at twenty one (21) locations.
- o A laboratory test program that consisted of gradation analysis, natural moisture content, pH and water soluble sulfate tests.
- o A summary of our interpretation of the observed subsurface conditions, including soil stratigraphy, depths to ground water and rock (as estimated by auger or sampler refusal), and the results of the Standard Penetration Tests.
- o Recommendations for foundation type, allowable soil bearing pressure, bearing levels, and estimated settlements.
- o Recommendations for slab subgrade preparation, site preparation, fill and backfill, temporary control of water, lateral earth pressure and construction monitoring.

II. BACKGROUND

Conestoga-Rovers & Associates (CRA) furnished Empire with a geotechnical investigation plan (Figure 2) revised September 18, 1992. This plan shows the locations of the existing and proposed facilities, the existing topography and the test boring and sampling locations. A set of drawings entitled "Groundwater Treatment System" (C-3, C-9, C-10 and C-13) and dated September 13, 1992 illustrate the plan and elevation details of the proposed ground water treatment building along with its process equipment layout. CRA provided Empire with a list of the proposed equipment weights which range from 1,100 pounds for Nutrient Tank to 196,400 pounds for Bio Reactor. Empire was also provided with a copy of the following documents:

- Consent Decree
- Site Specific Health and Safety Plan dated August, 1992
- Record of Decision, Attachment 3 - Summary of Most Representative Contaminants in Each Media for the Summit National Site
- Technical Memorandum No. 7, Bedrock Profiling
- Well Log for MW-26

The project site occupies the southeastern quadrant of the intersection of U.S. Route 224 and Ohio Route 225 in Deerfield Township. We understand that the site was previously used to mine coal. The site had been filled with soil and the existing topography is relatively level. The soils and water at the site are reportedly contaminated. The area is generally covered with grass, plants and/or brush. Some trees are present at the eastern and southern sections of the site. Two ponds, identified as East Pond and West Pond on the plans, are present in the central sections of the site. Stockpiles of fill materials, debris, steel and wood pieces were noted over the site during our field explorations. Existing grades in the proposed treatment building area range from about 1090 to 1093 feet.

The proposed ground water treatment building will be a steel framed, pre-engineered, one-story structure with a finished floor elevation of 1095 feet. The building will consist of about 30'x40' office area within its western section and approximately 56'x66' treatment area in its eastern section. The building structure for the office and treatment areas will be 14 and 30 feet high, respectively, above the floor level. Exterior grades will be lower than the finished

floor elevation of the building. The exception would be at the northeastern corner of the building where a berm up to 3 feet higher than the floor level is planned. The plans indicate three sediment and rubble stockpiles in the proposed building area. Column and wall loads for the proposed building are not available to Empire. The building floor slab will temporarily be subjected to empty weight of equipments during their installation and maintenance. This weight is typically up to 4,200 pounds however, sand filter, bio reactor and liquid carbon weigh up to 20,000 pounds. The equipments will be supported on independent foundations.

III. SUBSURFACE EXPLORATION

The subsurface conditions in the proposed ground water treatment building area were explored by drilling three (3) soil test borings, B-1 through B-3. Two (2) test borings, B-4 and B-5, were drilled in the temporary treatment facility and waste consolidation area. Twenty one (21) borings to a maximum depth of 2 feet were completed to investigate soils/sediments to be treated. These borings were completed for environmental purposes. The location and the number of test borings were selected by others. CRA provided Empire with the field layout of the borings. Test Boring Location Plan (Drawing 1) in Appendix A shows the approximate test boring locations, B-1 through B-5. The locations of the shallow borings are shown on Figure 2 prepared by CRA and revised September 18, 1992. These shallow borings in our report have been identified using grid numbers corresponding to the location drilled.

Figure 2 shows "Top of Rebar Set @ Grid Point S005/E400" at an elevation of 1099.43 feet as a bench mark which is located at the northern site boundary between grids 1-4 and 1-5. Empire determined ground surface elevations at test boring locations B-1 through B-5 using optical differential leveling survey relative to this bench mark.

Empire advanced test borings B-1 through B-5 with an ATV mounted drill rig (CME 55) using hollow stem augers. Shallow borings were advanced with either the drill rig or A. G. Penetrometer. Standard Penetration Tests (SPT) and split-barrel sampling of soils per ASTM D 1586 were performed in the test borings typically continuously to a depth of 10 feet and at 5 foot intervals thereafter. Ground water levels were generally monitored in the augers within the boreholes immediately after the completion of drilling.

Test boring logs, which include classification of the recovered soil samples, the SPT N-values and ground water observations, are presented in Appendix B. The logs represent our interpretation of the subsurface conditions based on logs prepared by an Empire geologist. The lines designating the interfaces between various strata on the logs are approximate. The transition between strata may actually be gradual. The "General Information & Key To Subsurface Logs" included with the logs in Appendix B explains various terms and symbols.

The field in-place density and moisture content of soils determined using a nuclear density gauge at the twenty one (21) shallow boring locations are attached in Appendix C.

IV. LABORATORY TESTING

Sieve analyses per ASTM D 422 were completed on one (1) soil specimen selected from each test boring, B-1 through B-5, as well as the twenty one (21) shallow borings. Water (moisture) content determination tests per ASTM D 2216 were performed on all soil samples recovered from test borings B-1 through B-5. Six (6) soil specimens from borings B-1 through B-3 were tested for water soluble sulphate and pH. Detailed results of these tests are given in Appendix C. These tests were performed for environmental purposes.

V. SUBSURFACE CONDITIONS

Our interpretation of the subsurface conditions is based on the soils sampled at the test boring locations and the results of laboratory soil tests. We assume subsurface conditions are similar between and away from the test locations. The subsurface logs should be referred to for a specific description of the subsurface conditions at each boring location. The following description of subsurface conditions is general in nature.

The site was previously used to mine coal and fill materials subsequently have been placed to regrade the area. All the test borings revealed fill layers. The twenty one (21) shallow borings encountered existing fill to the planned boring termination depth of approximately 2 feet below grade. Test borings B-1 through B-3 drilled within the ground water treatment plant encountered the fill extending to depths of 13 feet in B-1 and B-2, and 14 feet in B-3. Boring B-4 at the waste consolidation area encountered fill to an estimated depth of 28

feet. Boring B-5 at the temporary soil treatment facility was terminated within the fill strata at a depth of 30 feet below the existing grades. The fill material typically consisted of silty clay containing variable quantities of fine to coarse sand and gravel, and is generally mixed with coal fragments. The unconfined compressive strength of soils is irrelevant due to being fill materials.

Auger or sampler refusal was encountered in test borings B-1 and B-3 at depths of 13.7 feet and 14.7 feet, respectively. Boring B-2 was advanced by augering to the planned depth of 15 feet and terminated within weathered rock. Boring B-4 encountered spoon refusal within weathered rock at a depth of 29.1 feet. Based on the well log MW-26 and bedrock profiling information provided by CRA along with the decomposed rock material observed within the test borings, we anticipate shale rock at the site. Empire did not perform rock coring at the site. Information on the depths to rock was obtained only at the test boring locations and may vary at other locations.

Free standing water was not encountered in the augers at the completion of drilling of test borings B-1 through B-3. Water was observed in the augers during or at the completion of drilling in test borings B-4 and B-5 at depths of 27 feet and 20.2 feet, respectively, below existing grades. In addition, water was observed in the shallow boring at grid 1-2 at a depth of 0.9 feet below grade. The soil samples were noted as being moist. The water level in the auger, or lack thereof, does not necessarily represent a stabilized ground water condition as the borehole remains open for a limited time. Ground water observation wells are a more reliable means of assessing water levels. We anticipate that perched water within the fill may be encountered at shallower depths during site development.

VI. GEOTECHNICAL RECOMMENDATIONS

A. General

The results of the subsurface explorations and our experience with similar soils indicate that the development of the proposed treatment facility at the site will require special attention to geotechnical engineering aspects during the design and construction of the project. A deep foundation system consisting of drilled piers or driven end bearing piles may be used for the proposed building structure and equipment foundations.

Existing fill materials in test borings B-1 through B-3 generally extended close to the bedrock. The fill is predominantly cohesive in texture and varies from a soft to hard consistency as indicated by the variable SPT N-values. This fill is considered unsuitable for providing uniform support to the proposed building and equipment foundations, slabs-on-grade, or any other load bearing structure. This fill may cause unpredictable excessive and/or differential settlements of the structures. Uniform support for shallow foundations may be achieved by removal of the existing fill and other unsuitable materials in their entirety, and replacement with compacted structural fill as necessary. This complete removal and replacement process, in our opinion, would be cost prohibitive.

As an alternate to the complete removal of the fill, the existing fill materials may remain in-place within the floor slab-on-grade areas provided the fill is densified and stabilized through heavy proofrolling to enhance the uniformity and improve the bearing characteristics of the subgrades. Unstable or inappropriate fill may have to be undercut upon proofrolling, if necessary. This will not eliminate the potential for floor slab settlement and the owner must assume the risk of settlement due to additional consolidation of the fill. Elimination of the risk could also be realized by structural support of the slab by the deep foundation system.

The subsurface soils are moisture sensitive due to fine grained constituents of the soils. These soils will be difficult to work with during wet or freezing conditions. Perched water zones or water seepage may be encountered at shallow depths during site development.

Based on the existing topography shown on the site plan and finished floor elevation of 1095.00 feet for the proposed building, the earthwork within the building will generally require as much as approximately 5 feet of structural fill to bring the existing grades to the design slab grades. These depths do not include the undercutting and replacement of any unsuitable soils.

B. Site Development

Site Preparation

Prior to the start of construction, vegetation, unsuitable soils, existing facilities and debris should be removed from the proposed slab-on-grade areas. The unsuitable soils include topsoil;

soils mixed with organics, roots or other deleterious materials; and soft, loose, very wet or frozen soils.

For slab-on-grade, the cleared areas should be observed by the geotechnical engineer. This monitoring should include proofrolling of the entire area with a 10 ton static weight non-vibratory roller or equivalent. We recommend using at least 10 overlapping passes of the roller in mutually orthogonal directions. The intent of this proofrolling is to detect zones of unsuitable materials and to improve bearing characteristics of the subgrades. If "pumping" or "weaving" is observed, the soft, wet or unsuitable material should be removed down to firm subgrade and replaced with structural fill. Remediation of large areas of stability should include the placement of a woven geotextile separation material over the subgrade and below the structural fill. Following proofrolling, the subgrades should be exposed minimally to construction traffic and adverse weather conditions to reduce its potential degradation.

We anticipate that excavations for grade beams, pile caps and shallow underground utilities can be performed using conventional open cut technique. Excavations should be performed in accordance with Occupational Safety and Health Administration (OSHA) standards for excavations (29 CFR Part 1926). Detailed recommendations for excavation slopes and supports with related soil classification are presented in the OSHA reference. As defined in the OSHA standard, the on-site soils will be classified as Type C. OSHA standards indicate that open excavations less than 20 feet deep in Type C soils may have a short-term maximum allowable side slope of 1.5:1 (horizontal to vertical). Flatter slopes may be necessary depending upon the subsurface conditions, including the presence of water, during construction. The contractor should evaluate and verify soil conditions during construction, and must be responsible for excavation safety.

Fill and Backfill

Fill placed within building areas should be compacted structural fill. Off-site imported structural fill should consist of approved crusher run stone, bank run sand and gravel, or coarse aggregate. The fill material should conform to a gradation similar to that specified in Table 1. The on-site soils should not be used as structural fill material. The fill should be clean and well

graded from coarse to fine. It should not contain roots or other organics, debris, deleterious materials, frozen soils, clay, or stones larger than 2 inches. Fill material should be approved by the geotechnical engineer prior to construction. Samples of the proposed fill material should be tested prior to the earthwork operations to determine the classification, the natural and optimum moisture contents, and maximum dry density of the soil.

TABLE 1
RECOMMENDED GRADATION OF FILL

SIEVE SIZE DESIGNATION	PERCENT PASSING BY WEIGHT
2 Inch	100
3/4 Inch	52-100
# 4	24-50
# 200	0-10

The fill material should be placed in loose layers not thicker than 8 inches. Each layer should be compacted at optimum moisture content, plus or minus two percent, to a density of not less than 95 percent of the maximum dry density as determined by ASTM D 1557. The density of each layer of compacted fill should be tested and approved by a qualified technician working under the direction of the geotechnical engineer. Additional fill should only be placed after the test results indicate that the required compaction has been achieved. Fill should not be placed, spread or rolled while it is frozen/thawing, or during unfavorable weather conditions.

Temporary Control of Water

Free standing water was not observed at shallow depths in test borings B-1 through B-3. Fluctuations in ground water levels generally occur with variations in precipitation, surface run-off and evaporation throughout the year. The ground water conditions during construction may differ from those noted during our exploration. We do not anticipate major ground water problems at the site during earthwork. Perched water within the fill will likely be encountered at shallow depths during wet periods.

The on-site clays and silts are not likely to yield significant amounts of water due to low permeability of these soils. Sand seams and layers would allow relatively free drainage of water. If water is encountered, appropriate dewatering techniques will be necessary during the construction. We anticipate that pumps with filtered sumps and/or trenches should be adequate for shallow excavations. The design, equipment, installation and maintenance of water control methods during excavation and backfill operations should be the responsibility of the contractor.

The on-site soils are susceptible to softening and losing their strength upon absorbing moisture when they are exposed. Such subgrade degradation often occurs because of excessive soil moisture, seepage of water and the movement of construction equipment. To reduce the amount of soil which becomes unsuitable due to high moisture content, it will be beneficial to perform earthwork at this site during a dry period. Appropriate site grading should be provided to facilitate drainage of surface water runoff during construction and after completion of the project.

C. Building and Equipment Foundations

Drilled Piers

The first foundation system recommended to support the proposed structure and equipments consists of cast-in-place, concrete, drilled piers bearing on competent bedrock. Drilled piers have relatively high compressive, uplift and lateral load capacities. A single pier may be used to support a column.

Piers should extend through the fill, native soils, coal and upper weathered rock, and socketed a minimum of 1.5 feet or one-pier diameter, whichever is greater, into competent bedrock. We recommend an allowable bearing pressure of 10 tons per square foot for piers with a diameter of 18 inches or more. Piers should be designed as end bearing and reinforced to resist moment and lateral loads. Piers should be sized to include the effect of a negative skin friction of 500 psf over the pier surface area. We anticipate that total vertical settlement of the pier bearing on competent rock should be limited to elastic shortening of the pier. Depending on pH of soil and water, the concrete for pier may degrade.

The drilled pier installation should conform to "Standards and Specifications for the Foundation Drilling Industry" by the Association of Drilled Shaft Contractors (ADSC). The pier construction should conform to the requirements of "Standard Specification for the Construction of End Bearing Drilled Piers" (ACI 336.1) and "Suggested Design and Construction Procedures for Pier Foundations" (ACI 336.3R). The installation of drilled piers should be continually monitored and approved by the geotechnical engineer or his designated representative. The subgrade of the piers should be cleared of loose and weathered rock fragments. The subgrade should be inspected for the presence of voids in rock. The voids should be filled with grout as necessary. We recommend that Empire be retained to review the specifications pertaining to drilled pier construction.

Construction of the drilled piers should be performed by an experienced contractor. Temporary casings may be required to prevent cave-in of the drilled shaft, reduce ground water entering the drilled holes and allow thorough cleaning of the bearing surface. The temporary casing should be seated directly on the bedrock surface. The temporary casing should be removed by a smooth continuous pull after a sufficient head of concrete has been placed to preclude adverse effects as a result of shaft squeezing or excess hydrostatic water pressure outside the casing.

The amount of ground water present at the time of shaft installation will be variable, dependent upon the soil strata directly above the bedrock. We recommend concrete be drop placed if no more than two (2) inches of water is present in the rock socket. If a greater depth of water is present and dewatering proves impractical, concrete should be placed using the tremie method. Loose spoil or mud left on the bedrock surface inside the casing should not be more than 1/4 inch thick.

Steel Piles

If removal of the on-site soils is not possible due to their contamination then a driven displacement foundation system should be employed. End bearing driven vertical steel H-piles may be used to support the proposed building and equipments. We anticipate that total vertical settlement of the pile bearing on competent bedrock should be limited to elastic shortening of

the pile and slight movement (approximately 1/4 inches) of the pile tip. Piles should conform to relevant ASTM and AISC standards. The maximum allowable load per steel pile driven to bear on competent bedrock as given in Table 2 has been reduced to include the effects of negative skin friction due to potential consolidation of the silty clay fill stratum. We recommend an epoxy or similar coating of the piles to reduce the potential for steel corrosion and negative skin friction. The material used to coat the piles should be resistant to corrosive effects of the contaminants present at the site.

TABLE 2
ALLOWABLE DESIGN LOAD PER PILE

HP SECTION GRADE A36	ALLOWABLE LOAD, KIPS
HP 10 x 42	40
HP 12 x 53	60
HP 13 x 73	70

The piles should be driven through the fill, underlying soils and coal to practical refusal on competent bedrock. Rock as estimated by spoon/auger refusal was encountered at depths of approximately 15 feet. For preliminary estimates, the approximate average length of piles may be assumed as 17 feet. Actual driven pile lengths will vary. If necessary, splicing should be conducted in strict accordance with the manufacturer's recommendations. A maximum of one (1) splice per pile may be made. The piles should be equipped with a cast steel shoe (such as Hard-Bite 77600 by the Associated Pile & Fitting Corporation or equivalent) to facilitate penetration through coal and broken and partially weathered rock, and to provide a broader pile bearing on "sound" bedrock. To augment the information regarding the type and quality of bedrock, we recommend that 2 or 3 borings with rock coring be drilled at the site.

For lateral stability, we recommend limiting the allowable horizontal load to 1 kip per pile. We recommend at least 3 piles for each column unless grade beams or a structural slab are provided. No resistance to uplift should be considered for the coated portion of the pile except that offered by the weight of the pile itself.

We recommend a minimum center to center pile spacing of 3.5 times the pile width (equivalent diameter). During installation, the pile axes inclination from vertical or the specified batter should be less than 1 percent unless approved by the structural engineer. The pile cap bottom should extend at least 4 feet below the lowest adjacent finished exterior grade to inhibit frost heave.

We estimate that a rated hammer energy of at least 15 kip-ft will be required for pile driving. The piling contractor should, however, determine the hammer type and energy required for pile installation prior to bidding for this project. A final set or driving resistance of 20 blows per inch for the last 3 consecutive inches should be achieved. The axial compressive load capacity of the piles should be confirmed by monitoring the pile penetration during driving. We recommend performing at least six dynamic tests with a pile driving analyzer (PDA) during pile installation. The refusal criteria should be reevaluated after PDA testing and adjusted if necessary to achieve design capacity or limit pile damage.

The pile driving should be performed under the observation of a geotechnical engineer. The engineer should prepare a report which includes a complete driving record and results of testing for each pile. The driving record should include location and number of pile, type and size of hammer used, type of driving cap, rate of operation of pile driving equipment, ground elevation, pile length, pile tip elevation before and after cut-off, continuous record of number of blows per foot of pile penetration, pile deviation and any unusual occurrence during driving.

We anticipate that the recommended driven piles may result in fewer construction related problems. We expect that pile driving will be relatively easy to weathered rock. Vibrations associated with pile driving may be transmitted to existing adjacent structures and equipments, if present. The design engineers should determine the permissible vibrations for satisfactory performance of equipments and their foundations. We recommend that vibration monitoring and/or mitigation measures be considered prior to driving to ascertain that peak particle velocity does not exceed the limiting velocities for equipments and structures.

As an alternative to steel H-piles, timber piles may be considered for economics. Timber

piles should conform to ASTM D-25 specifications. Failure loads for timber piles driven to practical refusal on competent rock typically correspond to the allowable compressive stress of timber rather than the bearing capacity of rock. Recommendations for timber piles will be provided upon request.

Under both the options, a structural slab and grade beams spanning between the pier or pile foundations may be required for the proposed building. The area under the structural slab or grade beam may, if necessary, be filled with uncontrolled fill after construction.

D. Slabs-on-Grade

The ground floor slabs may be designed as concrete slabs-on-grade ("floating" slabs). However, settlements of up to approximately 2 to 3 inches should be anticipated with the slab-on-grade option due to the presence of deep existing fill at the site. Our slab-on-grade recommendations are directed at reducing the potential slab settlements and not eliminating them. If the anticipated settlements of the slab are intolerable then a structural slab to span between grade beams and piers/piles should be designed.

The slabs should bear on at least a 24 inch thick base course layer consisting of crusher run stone, gravel or coarse aggregate. The base course should be placed over approved subgrade. Slabs-on-grade should be designed and constructed in accordance with ACI 302.1R (Guide for Concrete Floor and Slab Construction). A maximum modulus of subgrade reaction (k_s) of 100 pci on top of the base course may be used for slab thickness design. The slabs-on-grade should be isolated from foundations to allow movement of the foundations independent of the floor slabs.

We anticipate degradation of slab subgrade soils due to construction traffic. The floor slab areas should be thoroughly recompacted in mutually perpendicular directions prior to the placement of the base course and following controlled backfilling of the foundation areas and utility trenches. This recompaction should be continually monitored and approved by the geotechnical engineer. Soft/loose or yielding areas should be undercut and backfilled with structural fill.

Existing fill within slab-on-grade areas should be proofrolled in the presence of the geotechnical engineer or his qualified representative. If the subgrade is soft or if "pumping" or "rutting" is observed upon proofrolling, it should be undercut by at least 1 to 2 feet. If marginal pumping exists after 2 feet undercut, we recommend placing a woven geotextile (SUPAC 6WS or equivalent) in accordance with manufacturer's guidelines. Local areas of excessive pumping should be undercut further and backfilled with structural fill. Following the geotextile placement, the undercut areas should be backfilled with compacted structural fill to the design subgrade levels.

E. Foundation Walls

Exterior grades around the northeastern section of the building will be up to 3 feet higher than the finished floor level of the building. Foundation walls, which support unbalanced fill, should be designed to resist lateral earth pressure at rest using an equivalent fluid pressure of 60 pcf per foot depth. One-half of any surcharge load should be added to this pressure. These values assume no sloping backfill above the wall and do not include any hydrostatic pressure. These walls should be water-proofed.

F. Construction Monitoring

A geotechnical engineer should be retained during construction to monitor the removal of existing facilities, site preparation, the proofrolling of subgrades, the fill placement, the subgrades for foundations and slabs, and pile driving or drilled pier construction.

A commitment to a strong quality assurance program by the owner and designer may substantially reduce potential problems during and after the construction of the project. We recommend Empire Soils Investigations, Inc. be retained to perform the construction monitoring because of our familiarity with the subsurface conditions at the site.

VII. REMARKS

This report is intended for use by the client and its designated professionals to make site evaluations and to advance the design of the project. Use of this report for other purposes is not permitted without the written authorization of Empire Soils Investigations, Inc.

The evaluations and recommendations of this report are based upon a limited number of test borings. Soil conditions, particularly fills, change from one point to another. Therefore, different conditions may be encountered during construction in areas outside the test boring locations. If conditions observed at the site during construction are different than those described in this report, we should be immediately notified so that we may determine if such variations will require any changes in the geotechnical recommendations. The recommendations are based on preliminary information. Empire Soils Investigations, Inc. should be authorized to review the final site plan, architectural and structural drawings, and specifications to evaluate their conformity with our recommendations and to determine if any changes to the geotechnical recommendations are necessary.

This report, in its entirety, should be made available to prospective contractors as a reference document. We point out to prospective bidders that this report may not be sufficient to prepare a complete and accurate bid. Under no circumstances should the boring logs be separated from this report. We disclaim all responsibility and liability for any part of this report that is removed, quoted or reproduced separately from the entire report. This report has been prepared in accordance with generally accepted geotechnical engineering practices. No warranty or guarantee, either expressed or implied, is made. Our scope of services did not include environmental matters, slope stability analysis, and cost/quantity estimates.

We appreciate the opportunity of service on this project. If there are any questions regarding the report, or if we may be of further service during the final design and construction phases of the project, please contact us.

Respectfully Submitted,
EMPIRE SOILS INVESTIGATIONS, INC.

Sunil K. Mital

Sunil K. Mital, P.E.
Geotechnical Engineer

Gilbert Camp Jr. (mm)

Gilbert N. Camp, Jr., P.E.
Senior Geotechnical Engineer
Ohio Registration No. E-50123

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

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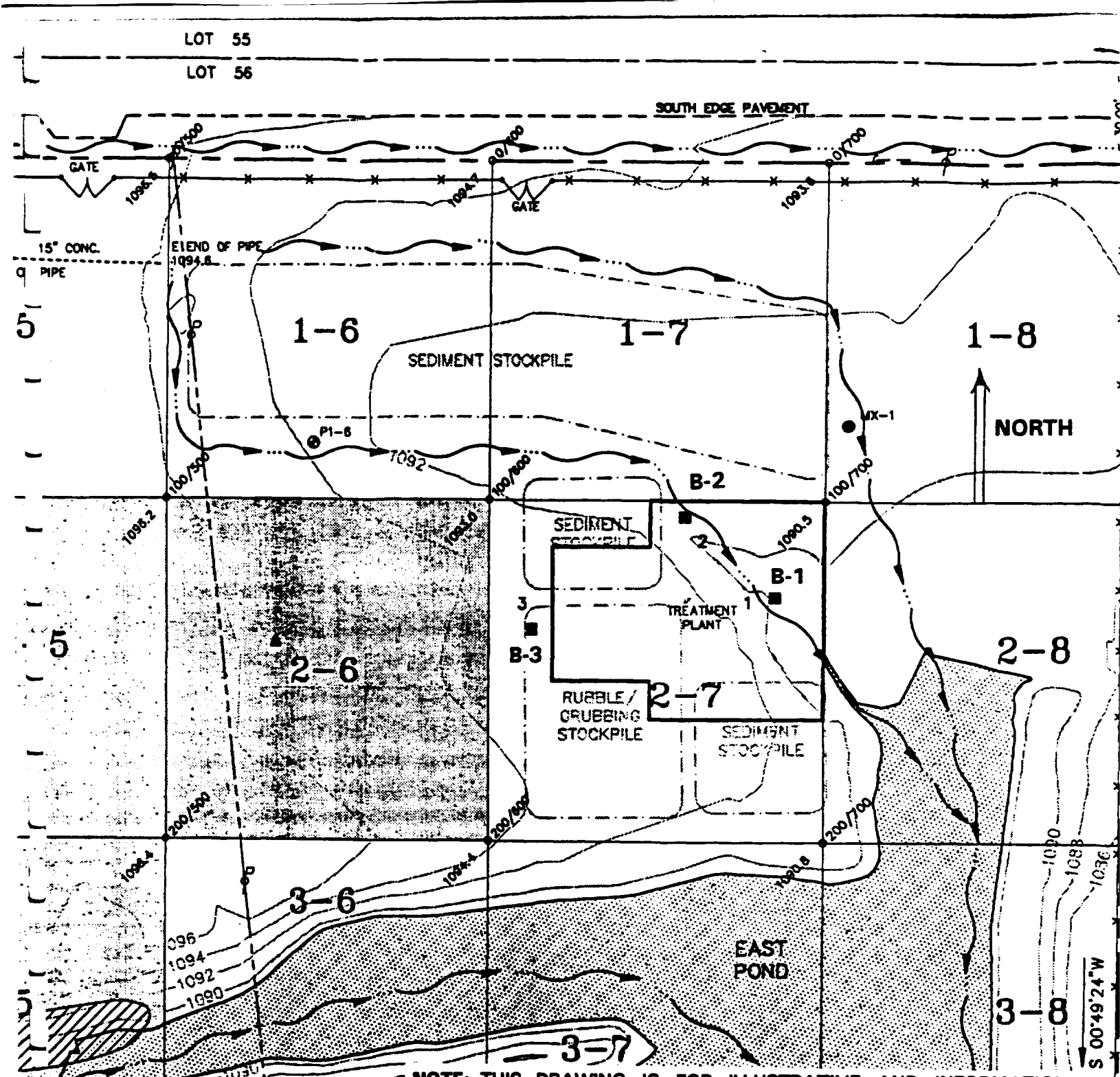
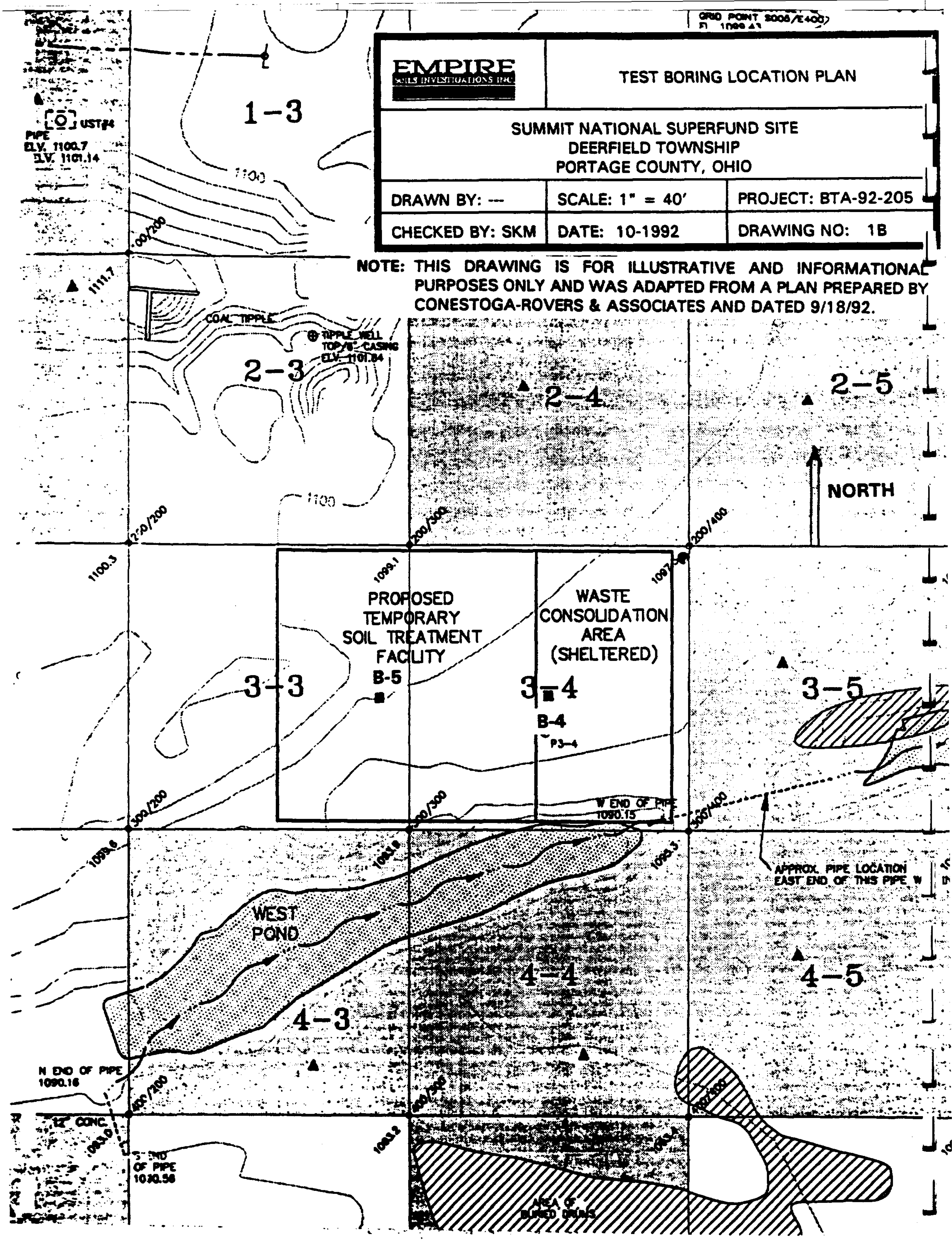
EMPIRE
SOILS INVESTIGATIONS INC

APPENDIX A



NOTE: THIS DRAWING IS FOR ILLUSTRATIVE AND INFORMATIONAL PURPOSES ONLY AND WAS ADAPTED FROM A PLAN PREPARED BY CONESTOGA-ROVERS & ASSOCIATES AND DATED 9/18/92.

EMPIRE	TEST BORING LOCATION PLAN	
SUMMIT NATIONAL SUPERFUND SITE DEERFIELD TOWNSHIP PORTAGE COUNTY, OHIO		
DRAWN BY: —	SCALE: 1" = 40'	PROJECT: BTA-92-205
CHECKED BY: SKM	DATE: 10-1992	DRAWING NO: 1A


EMPIRE SOILS INVESTIGATIONS INC
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1-3
UST#4
PIPE
ELV. 1100.7
ELV. 1101.14
1100
COAL TIPPLE
TIPPLE WELL
TOP/6" CASING
ELV. 1101.84
2-3
2-4
2-5
NORTH
1100
PROPOSED TEMPORARY SOIL TREATMENT FACILITY
WASTE CONSOLIDATION AREA (SHELTERED)
B-5
3-3
3-4
B-4
P3-4
3-5
W END OF PIPE
1090.15
APPROX. PIPE LOCATION
EAST END OF THIS PIPE W
WEST POND
4-3
4-4
4-5
N END OF PIPE
1090.16
12" CONC.
S END OF PIPE
1090.56
AREA OF BURIED DRUMS

EMPIRE
SOILS INVESTIGATIONS INC

APPENDIX B

GENERAL INFORMATION & KEY TO SUBSURFACE LOGS

The Subsurface Logs attached to this report present the observations and mechanical data collected by the driller at the site, supplemented by classification of the material removed from the borings as determined through visual identification by technicians in the laboratory. It is cautioned that the materials removed from the borings represent only a fraction of the total volume of the deposits at the site and may not necessarily be representative of the subsurface conditions between adjacent borings or between the sampled intervals. The data presented on the Subsurface Logs together with the recovered samples will provide a basis for evaluating the character of the significance relative to each other. Often analyses of standard boring data indicate the need for additional testing or sampling procedures to more accurately evaluate the subsurface conditions. Any evaluation of the contents of this report and the recovered samples must be performed by Professionals. The information presented in the following defines some of the procedures and terms used on the Subsurface Logs to describe the conditions encountered.

1. The figures in the Depth column defines the scale of the Subsurface Log.

2. The sample column shows, graphically, the depth range from which a sample was recovered. See Table 1 for a description of the symbols used to signify the various types of samples.

3. The Sample No. is used for identification on sample containers and/or Laboratory Test Reports.

4. Blows on Sampler - shows the results of the "Penetration Test", recording the number of blows required to drive a split spoon sampler into the soil. The number of blows required for each six inches of penetration is recorded. The first 6 inches of penetration is considered to be a seating drive. The number of blows required for the second and third 6 inches of penetration is termed the penetration resistance, N. The outside diameter of the sampler, the hammer weight and the length of drop are noted at the bottom of the Subsurface Log.

5. PID - Organic vapor measurements taken with a Photoionization Detector (PID). Measurements recorded in parts per million (ppm).

6. Symbol - Material symbol which indicates the type of soil that was encountered during classification of the recovered soil at the approximate depth. The symbol indicated represents an approximate boundary between soil types and the transition may be gradual.

7. All recovered soil samples are reviewed in the laboratory by an engineering technician, geologist, or geotechnical engineer, unless note otherwise. The visual descriptions are made on the basis of a combination of the driller's field descriptions and observations and the sample as received in the laboratory. The method of visual classification is based primarily on the United Soil Classification (ASTM D 2487-83) with regard to the particle size and plasticity. (See Table No. II) Additionally, the relative portion, by weight, of two or more soil types is Burmister, ASTM Special Technical Publication 479, June 1970. (See Table III) The description of the relative soil density or consistency is based upon the penetration records as defined on Table No. IV. The description of the soil moisture is based upon the relative wetness of the soils as recovered and is described as dry, moist, wet and saturated. Water introduced in the boring either naturally or during drilling may have affected the moisture condition of the recovered sample. Special terms are used as required to describe materials in greater detail; several such terms are listed in Table V. When sampling gravelly oils with a standard two inch diameter split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter. The presence of boulders and large gravel is sometimes, but not necessarily detected by an evaluation of the casing and samplers blows or through the "action" of the drill rig as reported by the driller.

8. The description of the rock shown is based on the recovered rock core and the driller's observations. The terms frequently used in the description are included in Table VI.

9. The stratification lines represent the approximate boundary between soil types and the transition may be gradual. Solid stratification lines are based on the driller's field observations.

10. Miscellaneous observations and procedures noted by the driller are shown in this column, including water level observations. It is important to realize the reliability of the water level observations depends upon the soil type (water does not readily stabilize in a hole through fine grained soils), and that drill water used to advance the boring may have influenced the observations. The ground water level typically will fluctuate seasonally. One or more perched or trapped water levels may exist in the ground seasonally. All the available readings should be evaluated. If definite conclusions cannot be made, it is often prudent to examine the conditions more thoroughly through test pit excavations or water observations wells.

11. The length of core run is defined as the length of penetration of the core barrel. Core recovery is the length of core recovered divided by the core run. The RQD (Rock Quality Designation) is the total pieces of NX core exceeding 4 inches in length divided by the core run. The size core barrel used is also noted.

DATE
STARTED: 5-7-91
FINISHED: 5-7-91

EMPIRE
SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

BORING NO.: B-1
SURF. ELEV.: 100.0±
SHEET 1 OF 1

PROJECT: SAMPLE SUBSURFACE LOG
PROJECT NO: _____
LOCATION: _____
CLIENT: _____

DEPTH-FT.	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	P.I.D.	SYMBOL	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	2	4	6	6	10	1		FILL	
		2			4			1		WELL GRADED GRAVELS, GW	
		3								POORLY GRADED GRAVELS, GP	
5							5			SILTY GRAVELS, GM	Water encountered at: 4.5 feet.
		2								CLAYEY GRAVELS, GC	
							6			WELL GRADED SANDS, SW	
10		1								POORLY GRADED SANDS, SP	
										SILTY SAND, SM	9 10
15							7			CLAYEY SAND, SC	
										INORG. SILT AND VERY F. SAND, CLAYEY SILT WITH LOW PLASTICITY, ML	
20										INORG CLAYS, GRAVELLY CLAY, SANDY CLAY, SILTY CLAY, LEAN CLAY, CL	
										ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY, OL	
25										INORGANIC SILTS, MH	
										INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS, CH	
										ORGANIC CLAYS OF MED TO HIGH PLASTICITY, OH	11
30										PEAT, Pt	
							8			SHALE	RUN: 32.0'-40.0' REC: 88% RQD: 66%
35										SANDSTONE	
										SILTSTONE	
40										LIMESTONE	

DRILLER: _____
DRILL RIG: CME - 45
METHOD OF INVESTIGATION: ASTM D-1586 Using Hollow Stem Augers
WEATHER: Sunny, 70 F
CLASSIFIED BY: By Geologist

TABLE I


Split Spoon Sample


Shelby Tube Sample


Auger or Test Pit Sample


Rock Core

TABLE III

The following terms are used in classifying soils consisting of mixtuers of two or more soil types. The estimate is based on weight of total sample.

Term	Percent of Total Sample
"and"	35 - 50 %
"some"	20 - 35 %
"little"	10 - 20 %
"trace"	less than 10 %

(When sampling gravelly soils with a standard split spoon, the true percentage of gravel is often not recovered due to the relatively small sampler diameter.)

TABLE V

Varved	-	Horizontal uniform layers or seams of soil(s).
Layer	-	Soil deposit more than 6" thick.
Seam	-	Soil deposit less than 6" thick.
Parting	-	Soil deposit less than ⅛" thick.
Laminated	-	Irregular, horizontal and angled seams and parings of soil(s).

TABLE II

Identification of soil types is made on basis of an estimate of particle sizes, and in the case of fine grained soils also on basis of plasticity.

Soil Type	Soil Particle Size	
Boulder	> 12"	Course Grained (Granular)
Cobble	3" - 12"	
Gravel-Coarse	3" - ¾"	
-Fine	¾" - #4	
Sand-Coarse	#4 - #10	
-Medium	#10 - #40	
-Fine	#40 - #200	
Silt: Non-Plastic (Granular) < .005 Clay: Plastic (Cohesive)		Fine Grained

TABLE IV

The relative compactness or consistency is described in accord with the following terms.

Granular Soils		Cohesive Soils	
Term	Blows per Foot, N	Term	Blows per Foot, N
Loose	< 11	Very Soft	< 3
Firm	11 - 30	Soft	3 - 5
Compact	31 - 50	Medium	6 - 15
Very Compact	> 50	Stiff	16 - 25
		Hard	> 25

(Large particles in the soils will often significantly influence the blows per foot recorded during the Penetration Test.)

TABLE VI

Rock Classification Terms		Meaning
Hardness:	Soft	Scratched by fingernail.
	Medium Hard	Scratheed easily by penknife.
	Hard	Scracthed with difficulty by penknife.
	Very Hard	Cannot be scratched by penknife.
Weathering:	Very Weathered	Judged from the relative amounts of disintegration iron staining, core recovery, clay seams, etc.
	Weathered	
	Sound	
Bedding:	Laminated	Natural Breaks in Rock Layers (< 1")
	Thin Bedded	(1" - 4")
	Bedded	(4" - 12")
	Thick Bedded	(12" - 36")
	Massive	(> 36")

(Fracturing refers to natural breaks in the rock oriented at some angle to the rock layers.)

DATE
STARTED: 9-9-92
FINISHED: 9-9-92

EMPIRE
SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

BTA-92-205

BORING NO.: B-1
SURF. ELEV.: 1091.4±
SHEET 1 OF 1

PROJECT: Summit National Superfund Site
CLIENT: Conestoga-Rovers & Associates Limited

LOCATION: Deerfield Township
Portage County, Ohio

DEPTH-FT.	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	AUCS*	SYMBOL	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	2	1	4	3	1.25		Red-brown and brown Silty Clay, gray laminated tr. f-c Sand, tr. f-c gravel, Coal fragments (moist, FILL)	*AUCS = Average Unconfined Compressive Strength in tons per sq. ft.
		2	3	3	3	3	6	1.25		Contains orange and gray partings	
		3	4	5	4	8	9	2		Brown-orange Silty Clay, gray laminated, tr. f-c sand, tr. f-c Gravel, tr. coal fragments (moist, FILL)	
5		4	11	14	11	17	25	4			
		5	6	12	9	14	21	3.75		Gray laminated, tr. coal fragments	
10											
		6	13	50/	.1		REF	2.75		COAL	
15										Boring Complete with Spoon refusal at 13.7'	
20											
25											

DRILLER: D. Beitz
DRILL RIG: CME-55 Track
METHOD OF INVESTIGATION: ASTM D-1586 USING HOLLOW STEM AUGERS
WEATHER: OVERCAST-64 DEGREES
CLASSIFIED BY: S. Bochenek

DATE STARTED: 9-9-92
FINISHED: 9-9-92

EMPIRE
SOILS INVESTIGATIONS INC.

SUBSURFACE LOG
BTA-92-205

BORING NO.: B-2
SURF. ELEV.: 1090.7±
SHEET 1 OF 1

PROJECT: Summit National Superfund Site
LOCATION: Deerfield Township
CLIENT: Conestoga-Rovers & Associates Limited
Portage County, Ohio

DEPTH-FT.	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	AUCS*	SYMBOL	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	1	2	1	3	3	1.25		Red-brown, brown Silty Clay, tr. f-c gravel, tr. f-c sand, tr. root (moist, FILL)	*AUCS = Average Unconfined Compressive Strength in tons per sq. ft.
		2	5	5	4	5	9	1.25		Brown Silty Clay, gray laminated, layer Coal fragments, tr. f-c gravel, tr. f-c sand (moist, FILL)	
		3	4	9	5	12	14	4.25		Coal fragments, tr. fine gravel	
5		4	33	18	22	19	40	4		Tr. fine-coarse gravel, fine-coarse Sand layer	
		5	8	19	13	20	32	2		Red-brown and orange brown Silty Clay, gray laminated, tr. f-c gravel, tr. f-c sand, contains f-c Sand seams (moist, FILL)	
10											
		6	23	70	50/	.1	REF	-		Coal fragments Weathered Rock	
15										Augered to 15.0' Boring Complete	
20											
25											

DRILLER: D. Beitz
DRILL RIG: CME-55 Track
METHOD OF INVESTIGATION: ASTM D-1586 USING HOLLOW STEM AUGERS
WEATHER: OVERCAST-64 DEGREES
CLASSIFIED BY: S. Bochenek

DATE
STARTED: 9-9-92
FINISHED: 9-9-92

EMPIRE
SOILS INVESTIGATIONS INC.

SUBSURFACE LOG

BTA-92-205

BORING NO.: B-3
SURF. ELEV.: 1093.8±
SHEET 1 OF 1

PROJECT: Summit National Superfund Site
CLIENT: Conestoga-Rovers & Associates Limited

LOCATION: Deerfield Township
Portage County, Ohio

DEPTH-FT.	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	AUCS*	SYMBOL	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	2	7	5	5	12	1.25		Red-brown and gray Silty Clay, tr. f-c sand, tr. f-c gravel, tr. coal fragments (moist, FILL)	*AUCS = Average Unconfined Compressive Strength in tons per sq. ft.
		2	3	2	3	2	5	1.25		Fine-coarse SAND (moist, FILL)	
										Red-brown and gray Silty Clay, tr. f-c sand, tr. f-c gravel (moist, FILL)	
		3	3	2	3	2	5	1.25		Red-brown and brown Silty Clay, gray partings, tr. f-c Sand, tr. f-c Gravel (moist, FILL)	
5		4	3	5	3	7	8	2.25		Little Coal fragments	
		5	3	11	7	11	18	3.25		Red-brown and brown Silty Clay, gray laminated, tr. f-c sand, f-c Sand seam, (moist, possible FILL)	
10											
		6	14	11	37	100/0.3	48	-		COAL Fragments and dark red-brown and black Silty Clay (moist)	
15										Boring Complete with Auger refusal at 14.7'	
20											
25											

DRILLER: D. Beitz
DRILL RIG: CME-55 Track
METHOD OF INVESTIGATION: ASTM D-1586 USING HOLLOW STEM AUGERS
WEATHER: PARTLY CLOUDY-64 DEGREES
CLASSIFIED BY: S. Bochenek

DATE STARTED: 9-8-92
FINISHED: 9-8-92

EMPIRE
SOILS INVESTIGATIONS INC.

SUBSURFACE LOG
BTA-92-205

BORING NO.: B-4
SURF. ELEV.: 1097.0±
SHEET 1 OF 1

PROJECT: Summit National Superfund Site
CLIENT: Conestoga-Rovers & Associates Limited
LOCATION: Deerfield Township, Portage County, Ohio

DEPTH-FT.	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	AUCS*	SYMBOL	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	3	7	5	7	12	-		Red-brown and black Clay, fine, tr. sand, tr. silt, little f-c Gravel, tr. coal fragments (moist, FILL)	*AUCS = Average Unconfined Compressive Strength in tons per sq. ft.
		2	5	4	5	3	9	-			
5		3	4	3	4	4	7	-		Little Coal fragments, tr. f-c gravel	
		4	4	5	3	3	8	-		Little f-c Gravel	
		5	1	3	3	2	6	0.75		Black-gray Clay, tr. fine sand, tr. silt, little f-c Gravel, some Coal fragments, light brown laminated in Clay (moist, FILL)	
10											
		6	2	3	4	3	7	0.75			
15											
		7	2	5	4	6	9	2			
20											
		8	3	6	5	7	11	2			
25											
		9	54	65	50/	0.1	REF	2		Weathered Bedrock	Driller notes water at 27.0'
30										Boring Complete with Spoon refusal at 29.1'	
35											
40											

DRILLER: D. Beitz
DRILL RIG: CME-55 Track
METHOD OF INVESTIGATION: ASTM D-1586 USING HOLLOW STEM AUGERS
WEATHER: PARTLY CLOUDY-70 DEGREES
CLASSIFIED BY: S. Bochenek

DATE
STARTED: 9-9-92
FINISHED: 9-9-92

EMPIRE
SOILS INVESTIGATIONS INC.

SUBSURFACE LOG
BTA-92-205

BORING NO.: B-5
SURF. ELEV.: 1098.4±
SHEET 1 OF 1

PROJECT: Summit National Superfund Site
LOCATION: Deerfield Township
CLIENT: Conestoga-Rovers & Associates Limited
Portage County, Ohio

DEPTH-FT.	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	N	AUCS*	SYMBOL	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	4	8	7	8	15	3.5		Dark brown Silty Clay, tr. f-c Sand, little Coal fragments (moist, FILL)	*AUCS = Average Unconfined Compressive Strength in tons per sq. ft.
		2	8	17	15	17	32	3.25		Black Silty Clay, light brown parting, tr. f-c gravel, some Coal fragments (moist)	
5		3	15	14	10	15	24	2		Coarse Sandy SILT layer	
		4	8	6	8	6	14	2			
		5	5	6	5	7	11	2			
10										Brown-gray Silty Clay, some Coal fragments, little f-c Gravel, tr. f-c sand (moist, FILL)	
		6	3	6	4	7	10	0.75		Red-brown Silty Clay, black lenses, some Coal fragments, tr. f-c sand (moist, FILL)	
15											
		7	4	9	6	11	15	-		Black-gray Silty Clay and Coal fragments, little f-c Gravel, tr. f-c sand (moist, FILL)	
20											Driller notes water at 20.2'
		8	3	4	4	5	8	0.75		Brown Silty Clay, little Coal fragments, little f-c gravel, tr. fine sand (moist, FILL)	
25											
		9	3	4	4	5	8	.0.75		Red-brown Clay parting	
30										Boring Complete at 30.0'	
35											
40											

DRILLER: D. Beitz
DRILL RIG: CME-55 Track
METHOD OF INVESTIGATION: ATSTM D-1586 USING HOLLOW STEM AUGERS
WEATHER: OVERCAST-62 DEGREES
CLASSIFIED BY: S. Bochenek

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 1-2
N-Values:	3,3,12,50/1"
Total Depth:	19"
Soil:	Reddish brown Silty CLAY, little f-c Sand, tr. f-c Gravel, some Brick (FILL). Depth of water-10"
Equipment:	A.G. Penetrometer

Boring Location:	Grid 2-2
N-Values:	3,8,7,7
Total Depth:	2.0'
Soil:	Brown Silty CLAY, tr. f-c sand, tr. fine gravel, Coal fragments (FILL)
Equipment:	A.G Penetrometer

Boring Location:	Grid 3-1
N-Values:	11,41,40,40
Total Depth:	2.0'
Soil:	Brown Silty CLAY, tr. f-c sand, tr. f-c gravel, f-c Sand seam, tr. coal fragments (FILL)
Equipment:	A.G. Penetrometer

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 2-4
N-Values:	4,11,12,13
Total Depth:	2.0'
Soil:	Brown Silty CLAY, tr. organics, tr. f-c gravel, tr. f-c sand, Coal fragments, f-c Sand seams (FILL)
Equipment:	A.G. Penetrometer

Boring Location:	Grid 2-5
N-Values:	8,10,10,7
Total Depth:	2.0'
Soil:	Brown Silty CLAY, some Slag, little f-c Gravel tr. f-c sand, f-c Sand lense (FILL)
Equipment:	CME-55 Rig

Boring Location:	Grid 2-6
N-Values:	3,5,5,6
Total Depth:	2.0'
Soil:	Brown Silty CLAY, little Organics, tr. f-c gravel, tr.f-c sand (FILL)
Equipment:	CME-55 Rig

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 3-5
N-Values:	2,5,4,6
Total Depth:	2.0'
Soil:	Brown Silty CLAY, tr. organics, tr. f-c gravel, tr. f-c sand, f-c Sand seams, Coal fragments (FILL)
Equipment:	CME-55 Rig

Boring Location:	Grid 4-4
N-Values:	3,3,7,8
Total Depth:	2.0'
Soil:	Brown Silty CLAY, some Coal fragments, little f-c Sand, little f-c Gravel (FILL)
Equipment:	CME-55 Rig

Boring Location:	Grid 4-5
N-Values:	5,12,12,9
Total Depth:	2.0'
Soil:	Coal, little orange f-c Sand, tr. clay (FILL)
Equipment:	CME-55 Rig

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 4-3
N-Values:	19,30,32
Total Depth:	18"
Soil:	Foundary SAND, some brown Silty Clay, tr. coal fragments, tr. f-c Gravel, tr. f-c Sand (FILL)
Equipment:	A.G. Penetrometer

Boring Location:	Grid 4-6
N-Values:	8,16,21,14
Total Depth:	2.0'
Soil:	Brown Silty CLAY, Gray laminated f-c foundary Sand, Sand seams, tr.f-c gravel (FILL)
Equipment:	A.G.Penetrometer

Boring Location:	Grid 4-7
N-Values:	3,2,2,1
Total Depth:	2.0'
Soil:	Brown Silty CLAY, little f-c foundary Sand, tr. f-c gravel, Coal layer (FILL)
Equipment:	A.G. Penetrometer

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 4-8
N-Values:	2,1,WR,1
Total Depth:	2.0'
Soil:	Brown Silty Clay, Orange partings, little f-c Gravel, tr. f-c sand, tr. coal fragments (FILL)
Equipment:	A.G. Penetrometer

Boring Location:	Grid 5-9
N-Values:	4,4,5,13
Total Depth:	2.0'
Soil:	Brown Silty CLAY, Little f-c Gravel, little f-c Sand, little Coal fragments, Coal layer (FILL)
Equipment:	A.G.Penetrometer

Boring Location:	Grid 1-9
N-Values:	3,4,6,7,
Total Depth:	2.0'
Soil:	1' Thick Topsoil, some brown Silty CLAY, tr. coal fragments, orange Sand seams (FILL)
Equipment:	A.G. Penetrometer

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 5-6
N-Values:	5,9,11,5
Total Depth:	2.0'
Soil:	F-c Sand, f-c Gravel, and Silt, tr. brick (FILL)
Equipment:	CME-55 Rig

Boring Location:	Grid 5-7
N-Values:	6,10,10,6
Total Depth:	2.0'
Soil:	Brown Silty CLAY with orange seams, tr. sand, tr. f-c gravel, Coal fragments (FILL)
Equipment:	CME-55 Rig

Boring Location:	Grid 6-7
N-Values:	6,15,12,14
Total Depth:	2.0'
Soil:	Brown Silty CLAY, tr. coarse gravel, tr. f-c sand, some Coal fragments, Sand seams (FILL)
Equipment:	A.G. Penetrometer

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE COUNTY, OHIO
EMPIRE PROJECT BTA-92-205
LOG OF BORINGS
DATE: SEPTEMBER 9 & 10 1992

Boring Location:	Grid 6-6
N-Values:	5,13,15,12
Total Depth:	2.0'
Soil:	Brown Silty CLAY, tr. f-c gravel, tr f-c sand, tr. coal fragments (FILL)
Equipment:	A.G. Penetrometer

Boring Location:	Grid 5-4
N-Values:	1,9,25/.1
Total Depth:	13"
Soil:	Brown Silty CLAY, some f-c Gravel, some f-c Sand (FILL)
Equipment:	A.G.Penetrometer

Boring Location:	Grid 5-2
N-Values:	5,22,25/.2
Total Depth:	14"
Soil:	Brown Silty CLAY, some f-c Sand, Coal layer, Coal fragments, orange f-c Sand seams (FILL)
Equipment:	A.G. Penetrometer

EMPIRE
SOILS INVESTIGATIONS INC.

APPENDIX C

FIELD IN-PLACE DENSITY TEST REPORT

EMPIRE SOILS INVESTIGATIONS INC

5 KNAGNER ROAD, P.O. BOX 2199, BALLSTON SPA, NY 12020 518/899-7491
5-8167 SOUTH PARK AVENUE, P.O. BOX 0913, HAMBURG, NY 14075 716/649-8110
105 CORONA AVENUE, GROTON, NY 13073 607/898-5881
140 TELEGRAPH ROAD, P.O. BOX 297, MIDDLEPORT, NY 14105 716/735 3502
4287 WITMER ROAD, B.P.O. BOX 188, NIAGARA FALLS, NY 14305-0188 716/297-5981
535 SUMMIT POINT DRIVE, HENRIETTA, NY 14467 716/350 1980
35 NATIONAL ROAD, EDISON, NJ 08817 908/287-2224
MORGANTOWN BUS. PARK, P.O. BOX 109, MORGANTOWN, PA 19543 215/286-8657

Project: SUMMIT NATIONAL SUPERFUND SITE Report No: _____

Client: CONESTOGA - ROVERS + ASSOCIATES LIMITED Date: 9/11/92

Contractor: _____ Job No.: BTA-92-205

Test No	Date of Test	Depth or Elevation	In-place Density (pcf)	In-place Moisture (%)	% Compaction	Proctor Code	Location and Remarks
1	9/11/92	EXISTING GRADES	97.3	29.3			GS 2-4 (½"-1" TOPSOIL PRESENT)
2			134.6	15.5			GS 2-5 " "
3			125.1	15.3			GS 2-6 " "
4			92.2	25.3			GS 2-5 (TRACE TOPSOIL)
5			97.4	20.1			GS 5'-2
6			109.3	17.7			GS 4-3
7			77.7	22.4			GS 4-4
8			84.6	26.3			GS 4-5
9			90.9	36.2			GS 4-6
10			85.6	23.8			GS 4-7
11			90.5	20.6			GS 4-8
12			111.1	13.6			GS 5-7
13	↓	↓	106.0	20.6			GS 6-7

Proctor Code	Maximum Density (pcf)	Optimum Moisture (%)	Material Type and Source
			EXISTING SOILS APPEAR TO BE FILL MATERIAL WITH COAL PRESENT. (DENSITY TESTS WILL BE INFLUENCED BY COAL HYDROCARBONS) ALL TESTS PERFORMED WITH SATURATED SURFACE SOIL CONDITIONS PER PREVIOUS TANKS

Respectfully submitted,

EMPIRE SOILS INVESTIGATIONS, INC.

Remarks: A CLIENT'S REPRESENTATIVE, STEVE HAYLE WAS PRESENT DURING TESTING

Technician Time: 7:00 – 12:00

Technician: ~~JAMES~~ KING

FIELD IN-PLACE DENSITY TEST REPORT

EMPIRE SOILS INVESTIGATIONS INC

5 KNABNER ROAD, P.O. BOX 2199, GALLSTON SPA, NY 12020 518/899-7491
S-5167 SOUTH PARK AVENUE, P.O. BOX 0913, HAMBURG, NY 14075 716/649-8110
105 CORONA AVENUE, GROTON, NY 13073 607/898-5881
140 TELEGRAPH ROAD, P.O. BOX 297, MIDDLEPORT, NY 14105 716/735-3502
4287 WITMER ROAD, B.P.O. BOX 188, NIAGARA FALLS, NY 14305-0188 716/297-5981
535 SUMMIT POINT DRIVE, HENRIETTA, NY 14467 716/359-1900
35 NATIONAL ROAD, EDISON, NJ 08817 908/287-2274
MORGANTOWN BUS. PARK, P.O. BOX 189, MORGANTOWN, PA 19543 215/286-6657

Project: SUMMIT NATIONAL SUPERFUND SITE Report No: _____

Client: _____ Date: 9/11/92

Contractor: Page 2 Job No.: BTA-92-205

Test No	Date of Test	Depth or Elevation	In-place Density (pcf)	In-place Moisture (%)	% Compaction	Proctor Code	Location and Remarks
14	9/11/92	SURFACE GRADES	104.1	20.9			GS 5-6
15			110.7	15.7			GS 6-6
16			92.2	17.7			GS 5-4
17			72	38.2			GS 3-1
18			99.2	18.3			GS 2-2
19			*	*			GS 1-2 * NO TEST DUE TO STANDING WATER IN AREA
20			115.5	10.7			GS 5-9
21			73.9	40.3			GS 1-9 (1/2" - 1" TOPSOIL PRESENT ROOTS, COAL

Proctor Code	Maximum Density (pcf)	Optimum Moisture (%)	Material Type and Source

Respectfully submitted,

Remarks: _____

EMPIRE SOILS INVESTIGATIONS, INC.

Technician Time: _____

Technician: _____

E-C Press Inc East Aurora, NY F0889-01

SUMMARY OF LABORATORY TEST RESULTS
WATER CONTENT

SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD TOWNSHIP, PORTAGE CO., OHIO

LAB NO.	BORING NO.	SAMPLE NO.	SAMPLE DEPTH (FT)	WATER CONTENT (%)
1429.001	B-1	S-1	0.0 - 2.0	30.6
1429.002		S-2	2.0 - 4.0	25.2
1429.003		S-3	4.0 - 6.0	20.8
1429.004		S-4	6.0 - 8.0	17.2
1429.005		S-5	8.0 - 10.0	14.8
1429.006		S-6	13.0 - 15.0	13.4
1429.007	B-2	S-1	0.0 - 2.0	25.8
1429.008		S-2	2.0 - 4.0	26.6
1429.009		S-3	4.0 - 6.0	20.5
1429.010		S-4	6.0 - 8.0	13.9
1429.011		S-5	8.0 - 10.0	17.1
1429.012		S-6	13.0 - 15.0	8.5
1429.013	B-3	S-1	0.0 - 2.0	21.9
1429.014		S-2	2.0 - 4.0	18.0
1429.015		S-3	4.0 - 6.0	30.4
1429.016		S-4	6.0 - 8.0	22.9
1429.017		S-5	8.0 - 10.0	18.7
1429.018		S-6	13.0 - 15.0	26.2
1429.019	B-4	S-1	0.0 - 2.0	24.0
1429.020		S-2	2.0 - 4.0	18.9
1429.021		S-3	4.0 - 6.0	15.4
1429.022		S-4	6.0 - 8.0	19.3
1429.023		S-5	8.0 - 10.0	18.4
1429.024		S-6	13.0 - 15.0	17.1
1429.025		S-7	18.0 - 20.0	13.3
1429.026		S-8	23.0 - 25.0	15.0
1429.027		S-9	28.0 - 30.0	12.3
1429.028	B-5	S-1	0.0 - 2.0	17.0
1429.029		S-2	2.0 - 4.0	15.6
1429.030		S-3	4.0 - 6.0	14.0
1429.031		S-4	6.0 - 8.0	15.6
1429.032		S-5	8.0 - 10.0	16.6
1429.033		S-6	13.0 - 15.0	15.9
1429.034		S-7	18.0 - 20.0	14.8
1429.035		S-8	23.0 - 25.0	18.9
1429.036		S-9	28.0 - 30.0	16.6

HUNTINGTON ANALYTICAL LABORATORY
ENVIRONMENTAL

Inorganic Wet Chemical Analyses

Analyte: WATER SOLUBLE SULFATE

EPA Method No.: 375.4

Sample Date	HAS Sample #92-	Client I.D.	Date Prepared	Date Analyzed	Method Detection Limit	Result	Units	QC in %
		B-1						
9/24/92	1450-001	S-1	10/1/92	10/1/92	10	389	mg/kg	95*
		B-1						
9/24/92	1450-002	S-2	10/1/92	10/1/92	10	1366	mg/kg	95*
		B-2						
9/24/92	1450-003	S-2	10/1/92	10/1/92	10	1022	mg/kg	95*
		B-2						
9/24/92	1450-004	S-3	10/1/92	10/1/92	10	1053	mg/kg	95*
		B-3						
9/24/92	1450-005	S-3	10/1/92	10/1/92	10	1390	mg/kg	95*
		B-3						42**
9/24/92	1450-006	S-4	10/1/92	10/1/92	10	1537	mg/kg	95*

* This indicates that a 95 % confidence limit was achieved with an EPA Quality Control Check analyzed with this sample.

** This sample was analyzed in duplicate with the RPD indicated above.

HUNTINGDON ANALYTICAL LABORATORY
ENVIRONMENTAL

Inorganic Wet Chemical Analyses

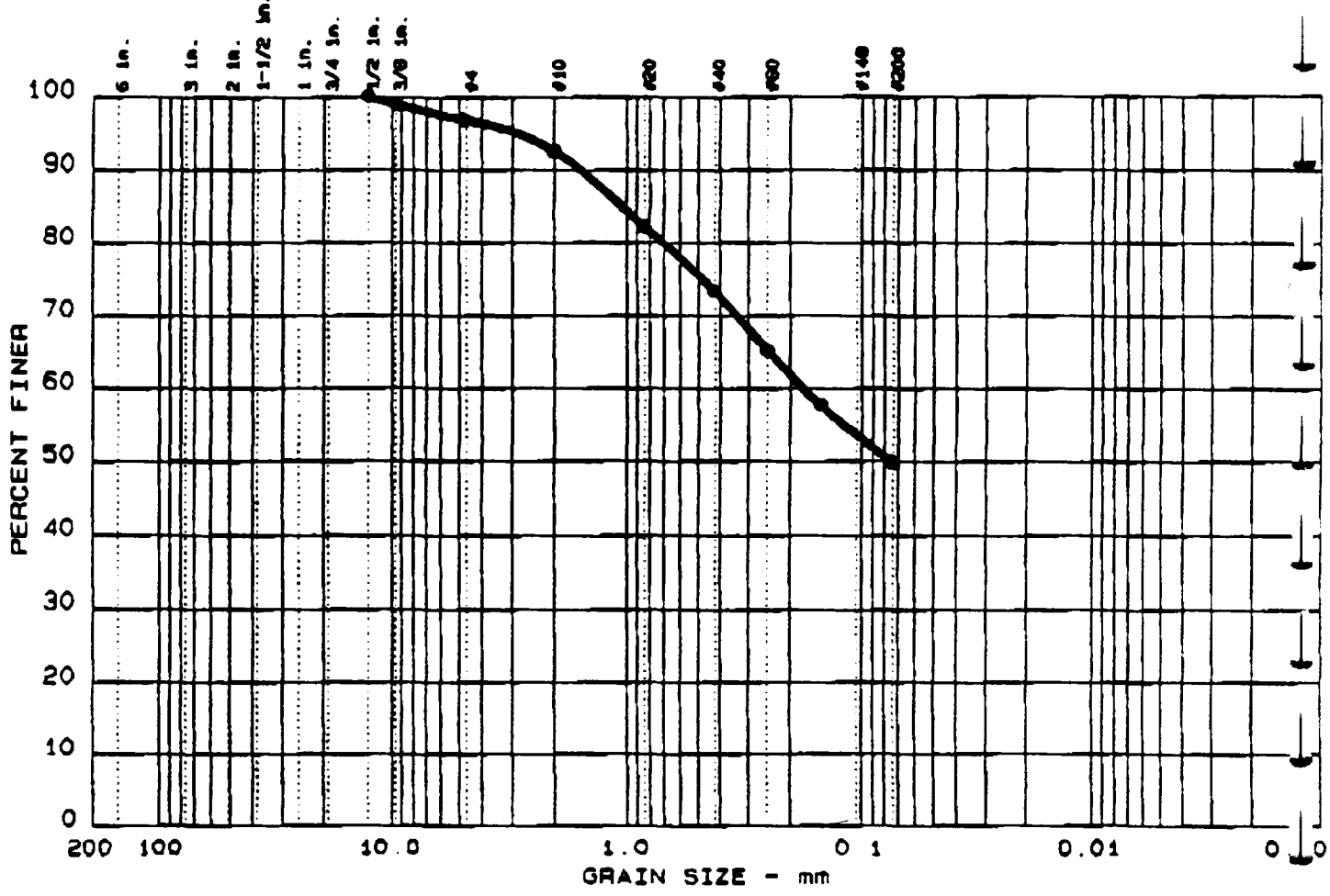
Analyte: pH

EPA Method No.: SW 846 9045

Sample Date	HAS Sample #92-	Client I.D.	Date Prepared	Date Analyzed	Method Detection Limit	Result	Units	QC in %
		B-1						
9/24/92	1450-001	S-1	9/29/92	9/29/92	0.10	5.22	S.U.	95*
		B-1						
9/24/92	1450-002	S-2	9/29/92	9/29/92	0.10	3.18	S.U.	95*
		B-2						
9/24/92	1450-003	S-2	9/29/92	9/29/92	0.10	5.83	S.U.	95*
		B-2						
9/24/92	1450-004	S-3	9/29/92	9/29/92	0.10	6.63	S.U.	95*
		B-3						
9/24/92	1450-005	S-3	9/29/92	9/29/92	0.10	3.77	S.U.	95*
		B-3						
9/24/92	1450-006	S-4	9/29/92	9/29/92	0.10	3.84	S.U.	95*

* This indicates that a 95 % confidence limit was achieved with an EPA Quality Control Check analyzed with this sample.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	7	0.0	3.2	47.1	49.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.04	0.18	0.07					

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY FINES AND SAND, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 6-7

Date: OCTOBER 6, 1992

Remarks:

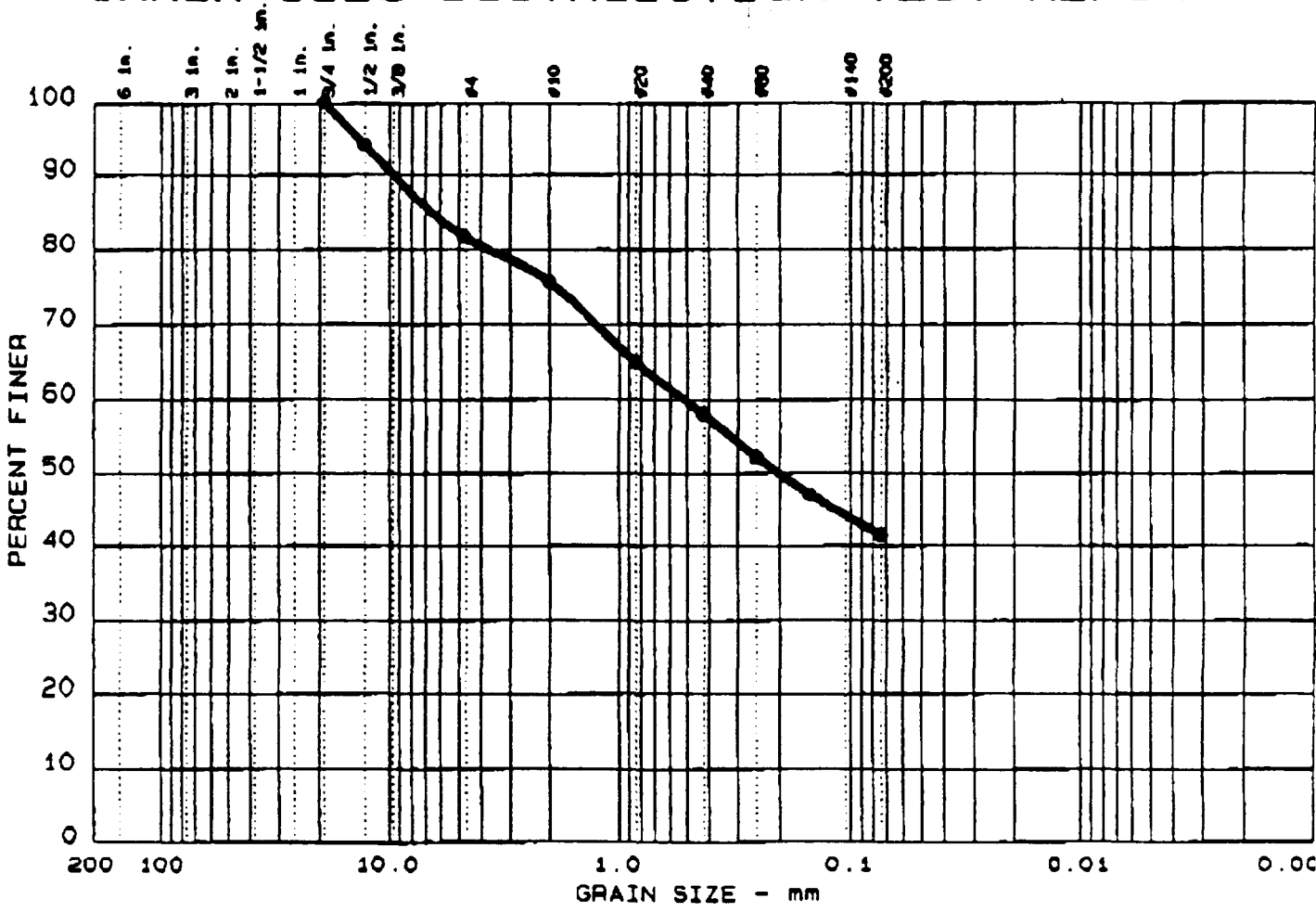
LAB NO. 1429.057

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	6	0.0	18.2	40.4	41.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_U
●			6.46	0.51	0.20					

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY FINES AND SAND, Little Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: 99 6-6

Date: OCTOBER 6, 1992

Remarks:

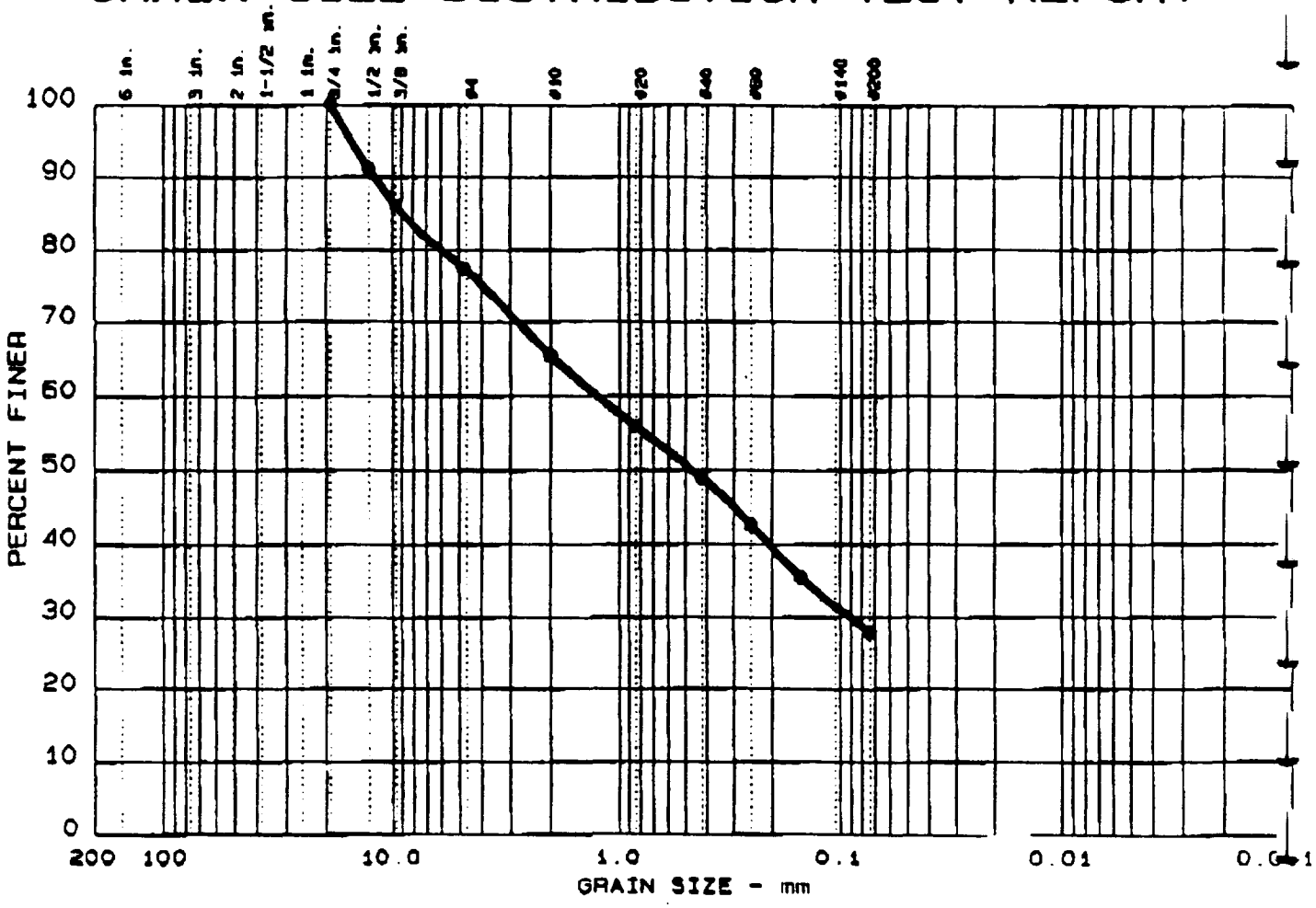
LAB NO 1429.056

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0.0	22.6	49.5	27.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			8.91	1.26	0.46	0.091				

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND, Some Fines & Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 5-9

Date: OCTOBER 6, 1992

Remarks:

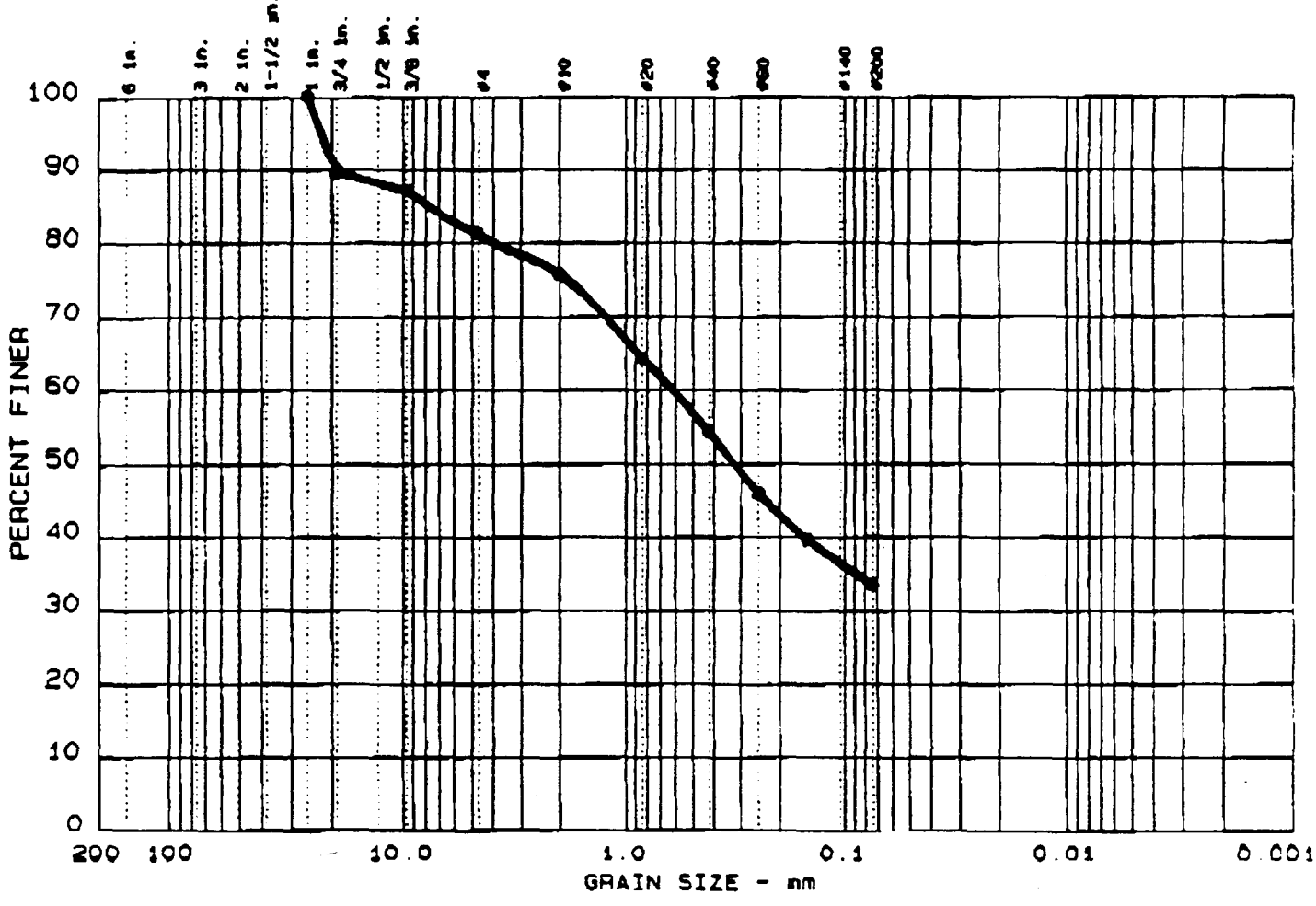
LAB NO. 1429.055

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	18.7	47.9	33.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_U
●			7.67	0.62	0.32					

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND, Some Fines, Little Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 5-7

Date: OCTOBER 6, 1992

Remarks:

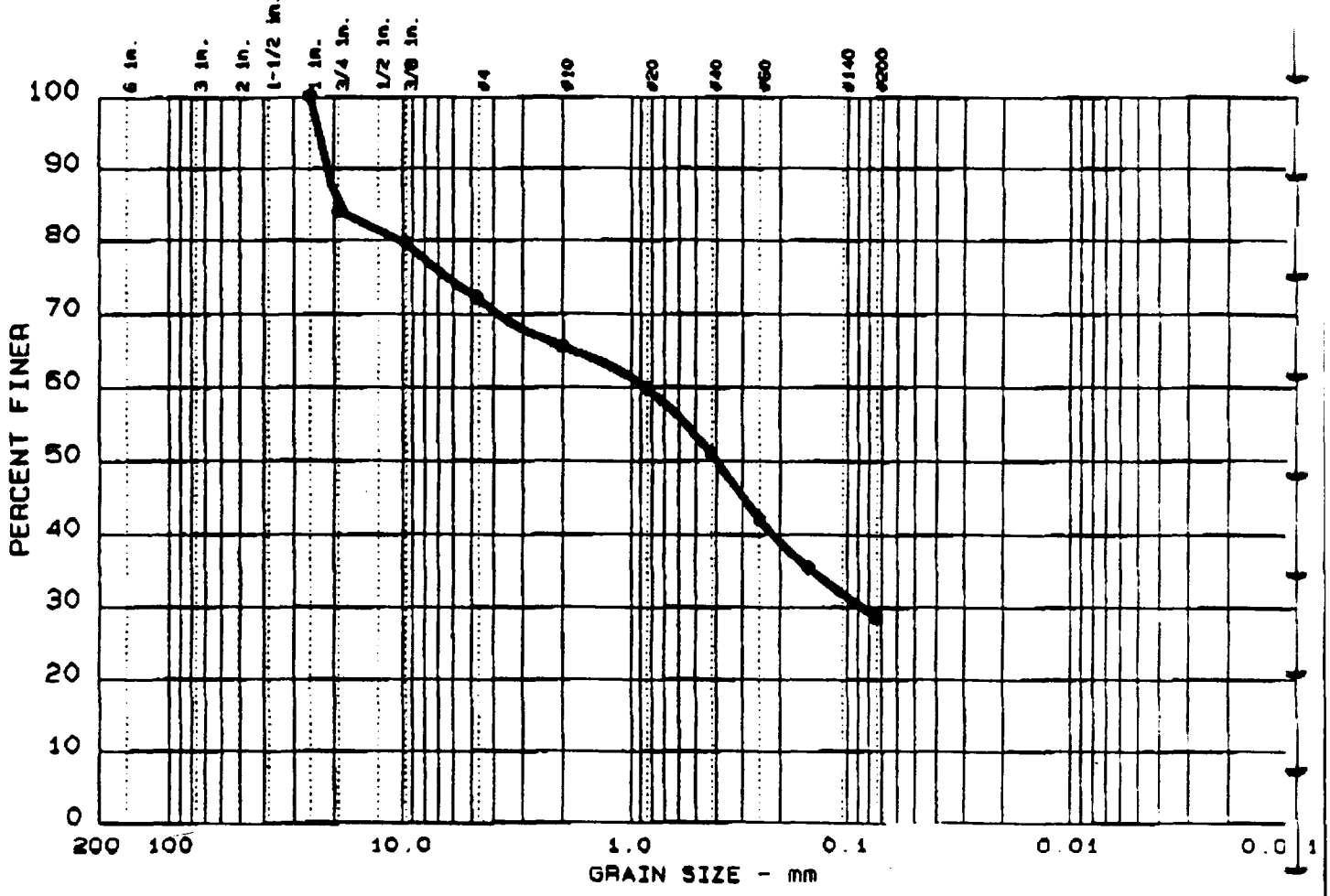
LAB NO. 1429.054

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	27.7	43.8	28.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			19.34	0.86	0.39	0.087				

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND, Some Fines & Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 5-6

Date: OCTOBER 8, 1992

Remarks:

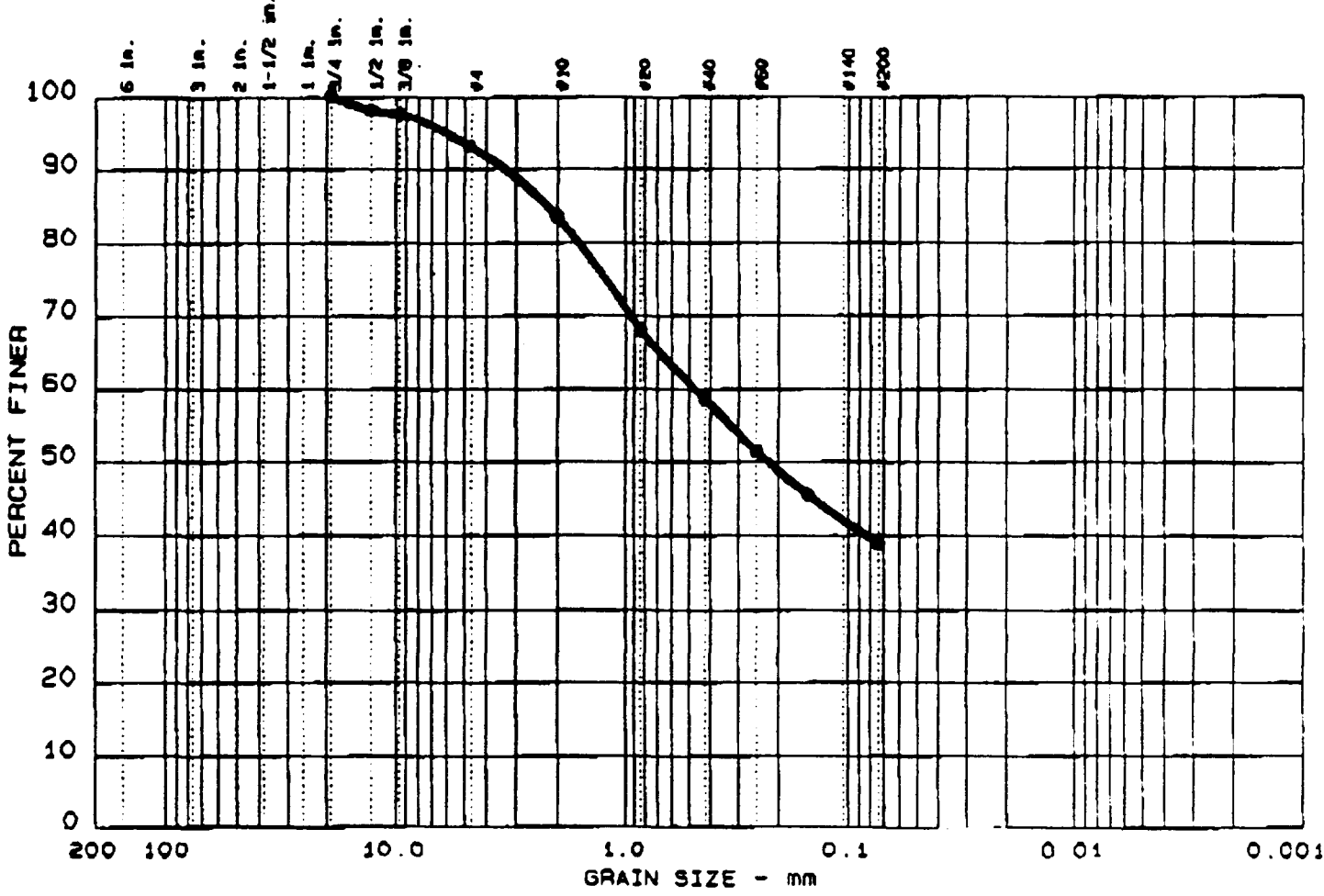
LAB NO. 1429.053

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	6.8	54.4	38.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_U
●			2.19	0.46	0.22					

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND AND FINES, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 5-4

Date: OCTOBER 6, 1992

Remarks:

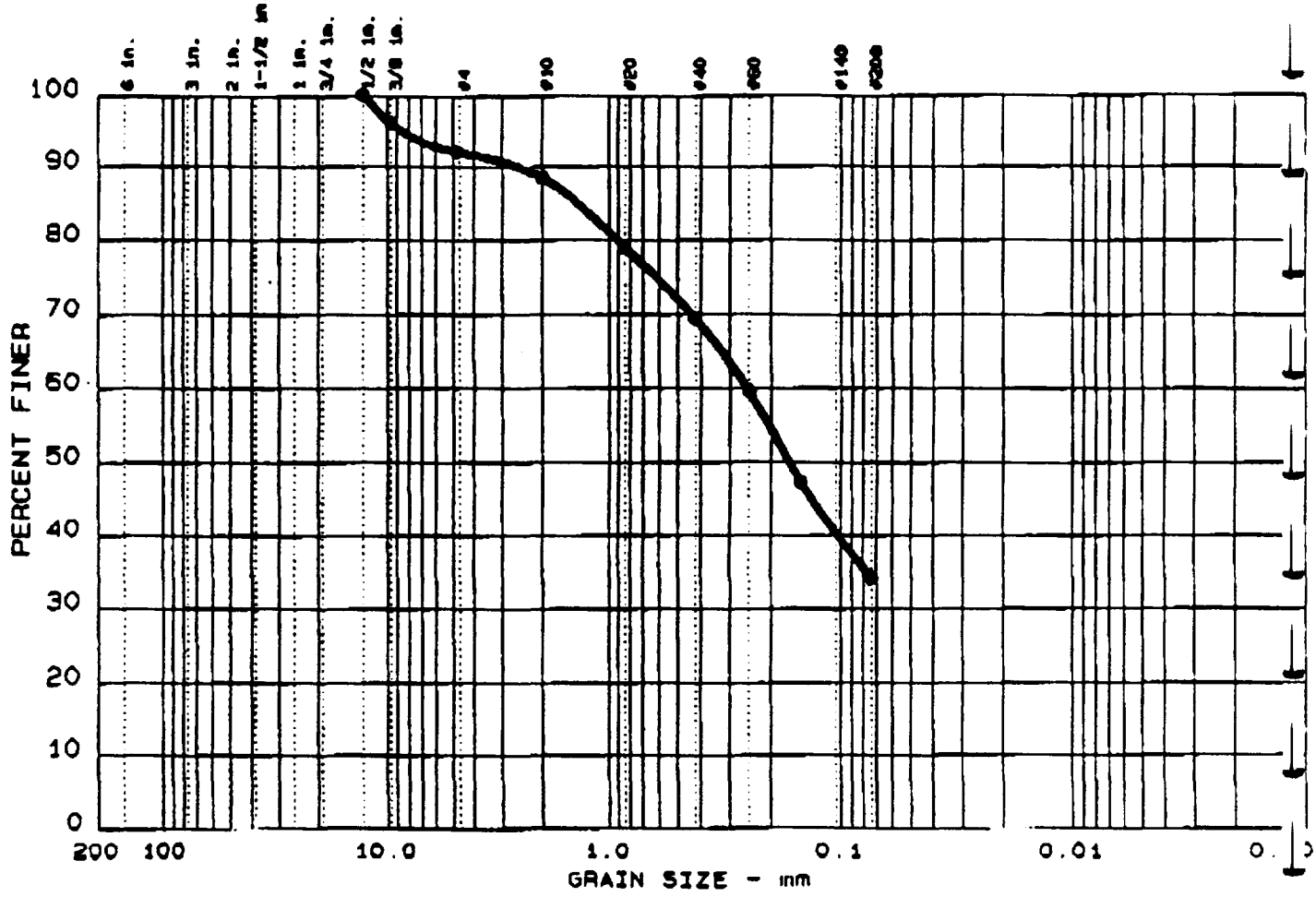
LAB NO. 1429.052

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	7.9	57.9	34.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.38	0.25	0.17					

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND, Some Fines, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 5-2

Date: OCTOBER 6, 1992

Remarks:

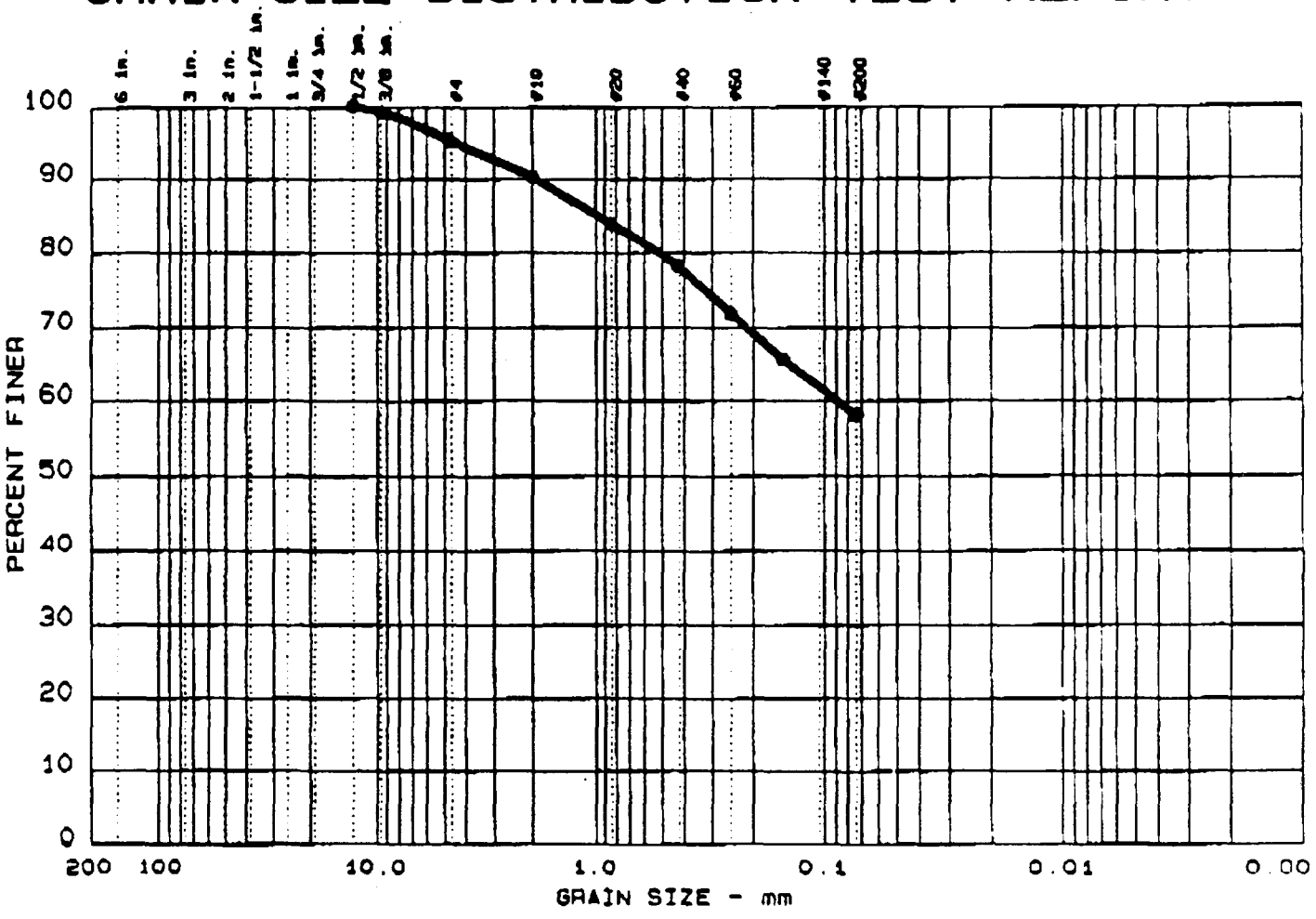
LAB NO. 1429.051

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	20	0.0	4.6	37.4	58.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.97	0.09						

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY FINES AND SAND, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: 09 4-8

Date: OCTOBER 6, 1992

Remarks:

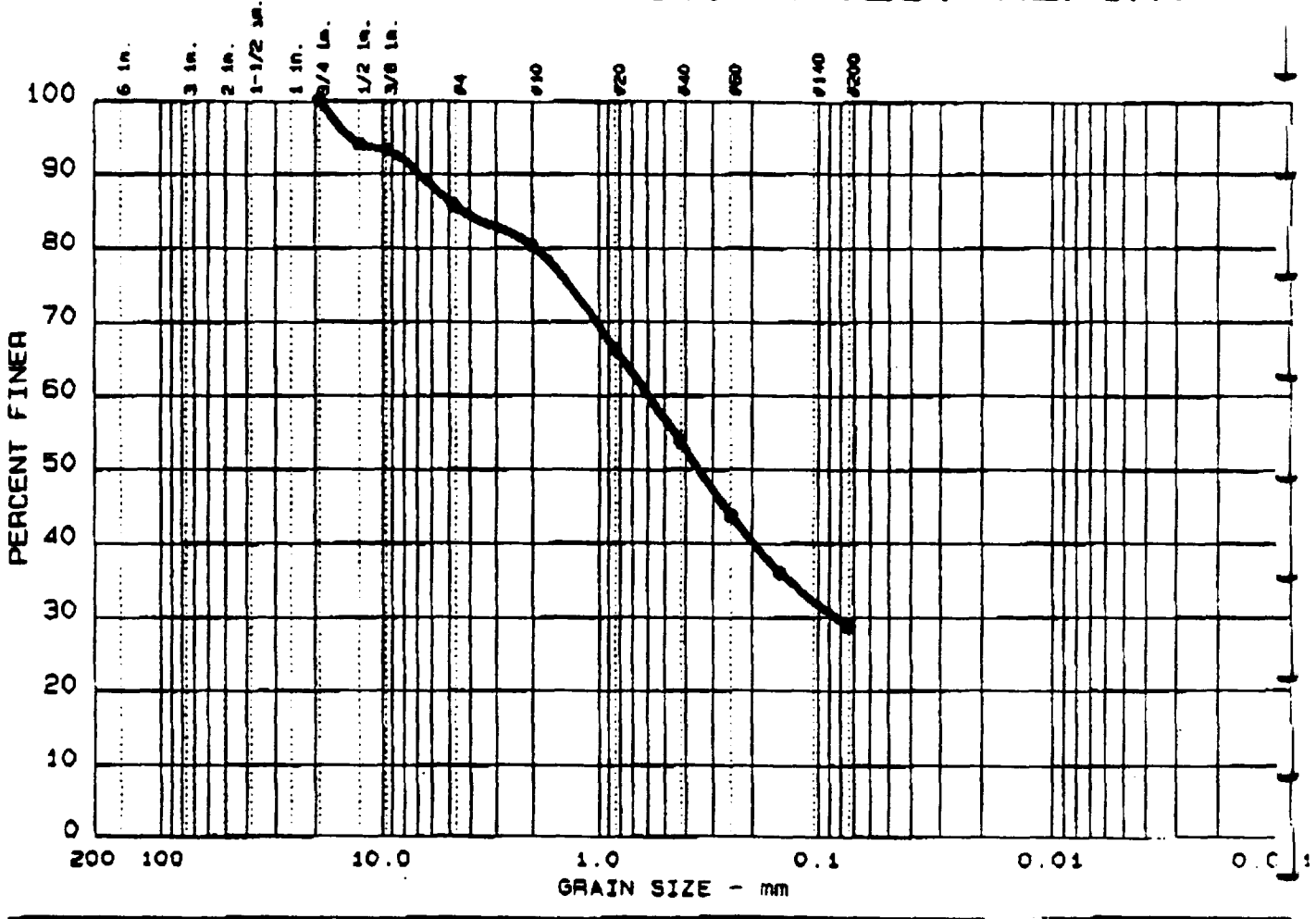
GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

LAB NO. 1429.050

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	18	0.0	14.3	57.1	28.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			4.37	0.59	0.35	0.085				

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND, Some Fines, Little Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 4-7

Date: OCTOBER 6, 1992

Remarks:

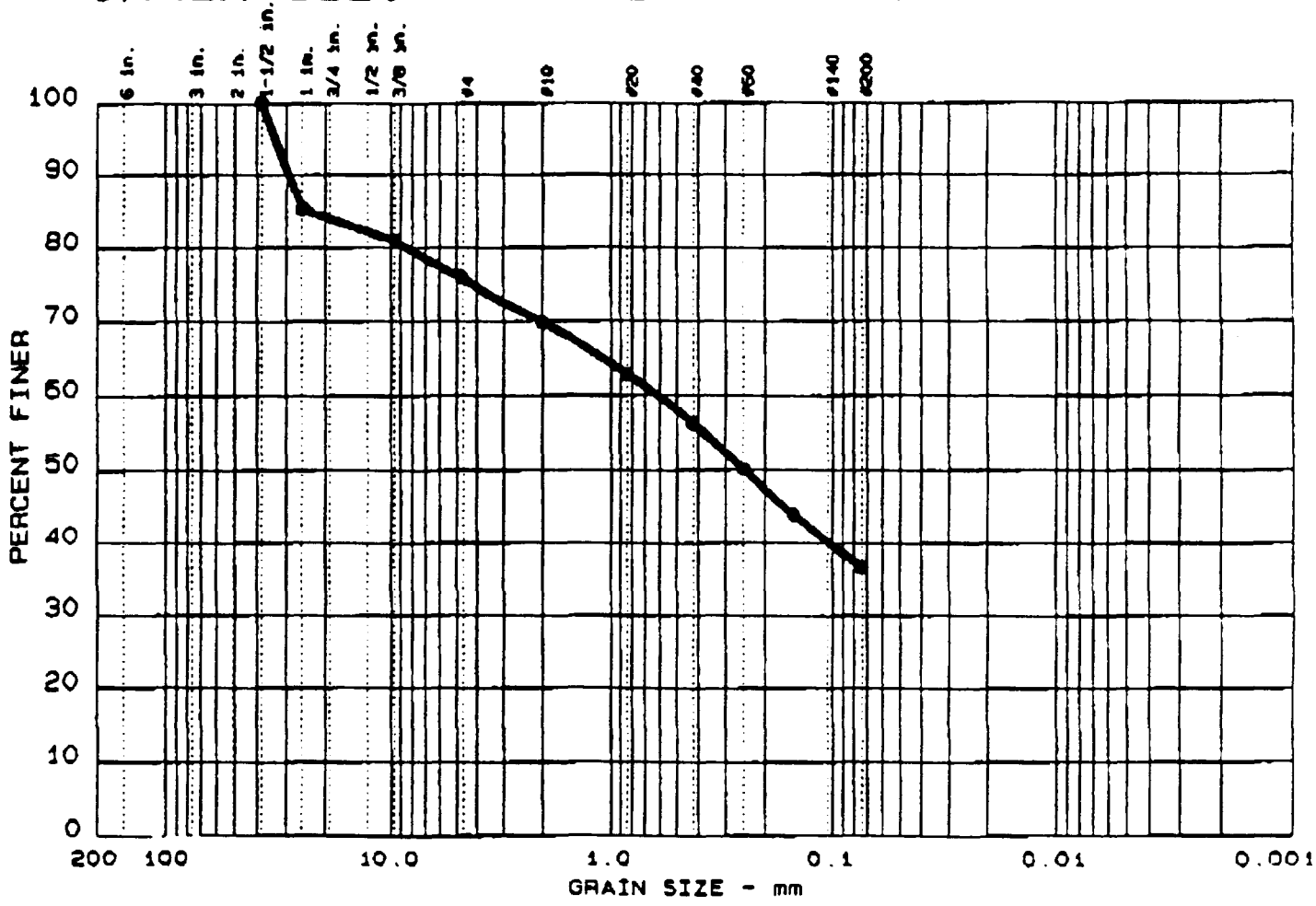
LAB NO. 1428.048

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	17	0.0	24.0	39.5	36.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_U
●			24.27	0.61	0.25					

MATERIAL DESCRIPTION	USCS	AASHTO
● GREY SAND AND FINES, Little Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 4-6

Date: OCTOBER 6, 1992

Remarks:

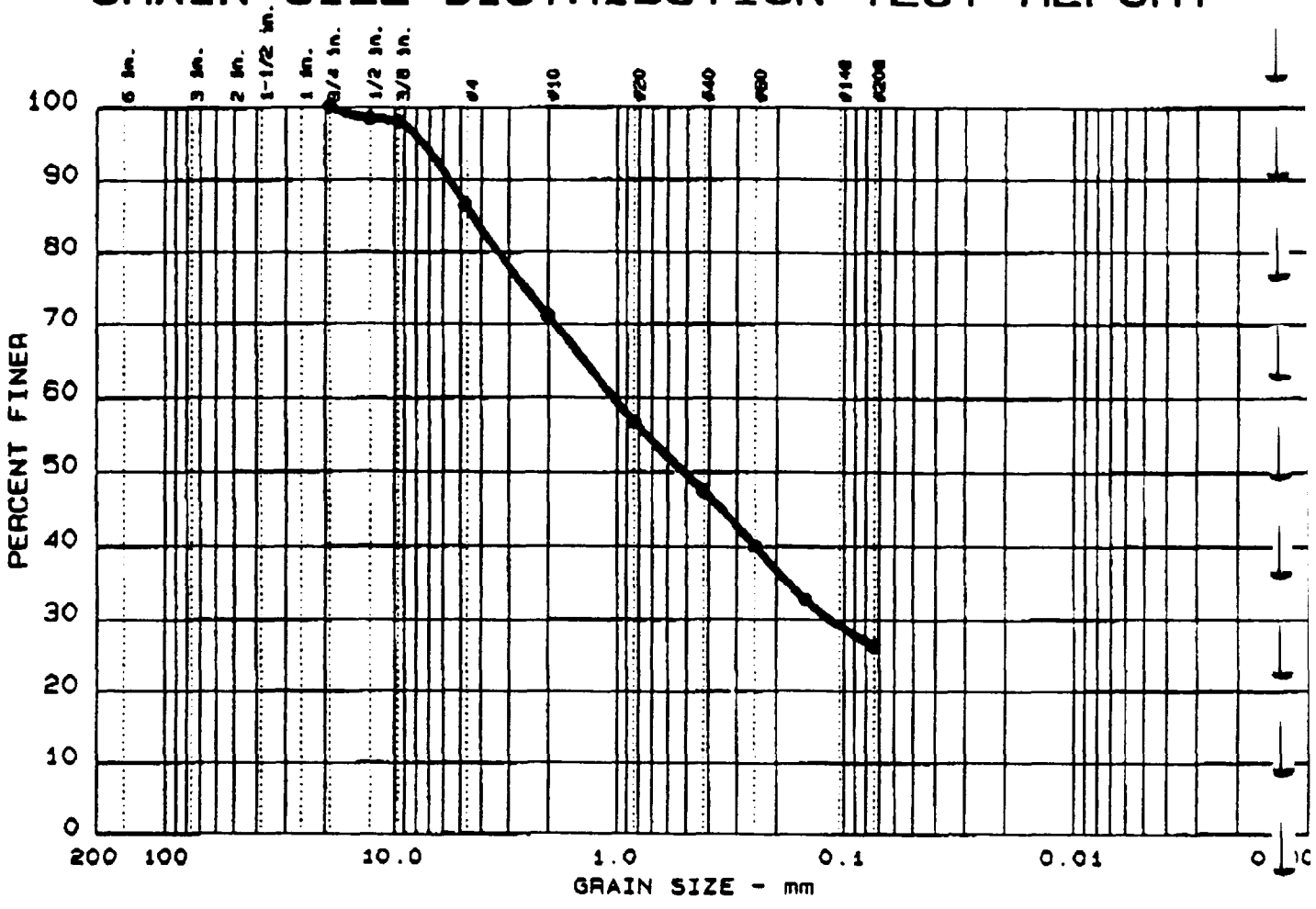
GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

LAB NO 1429.048

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	16	0.0	13.5	60.3	26.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			4.37	1.04	0.51	0.116				

	MATERIAL DESCRIPTION	USCS	AASHTO
●	BLACK SAND, Some Fines, Little Gravel		

Project No.: BTA-92-206
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 4-5

Date: OCTOBER 6, 1992

Remarks:

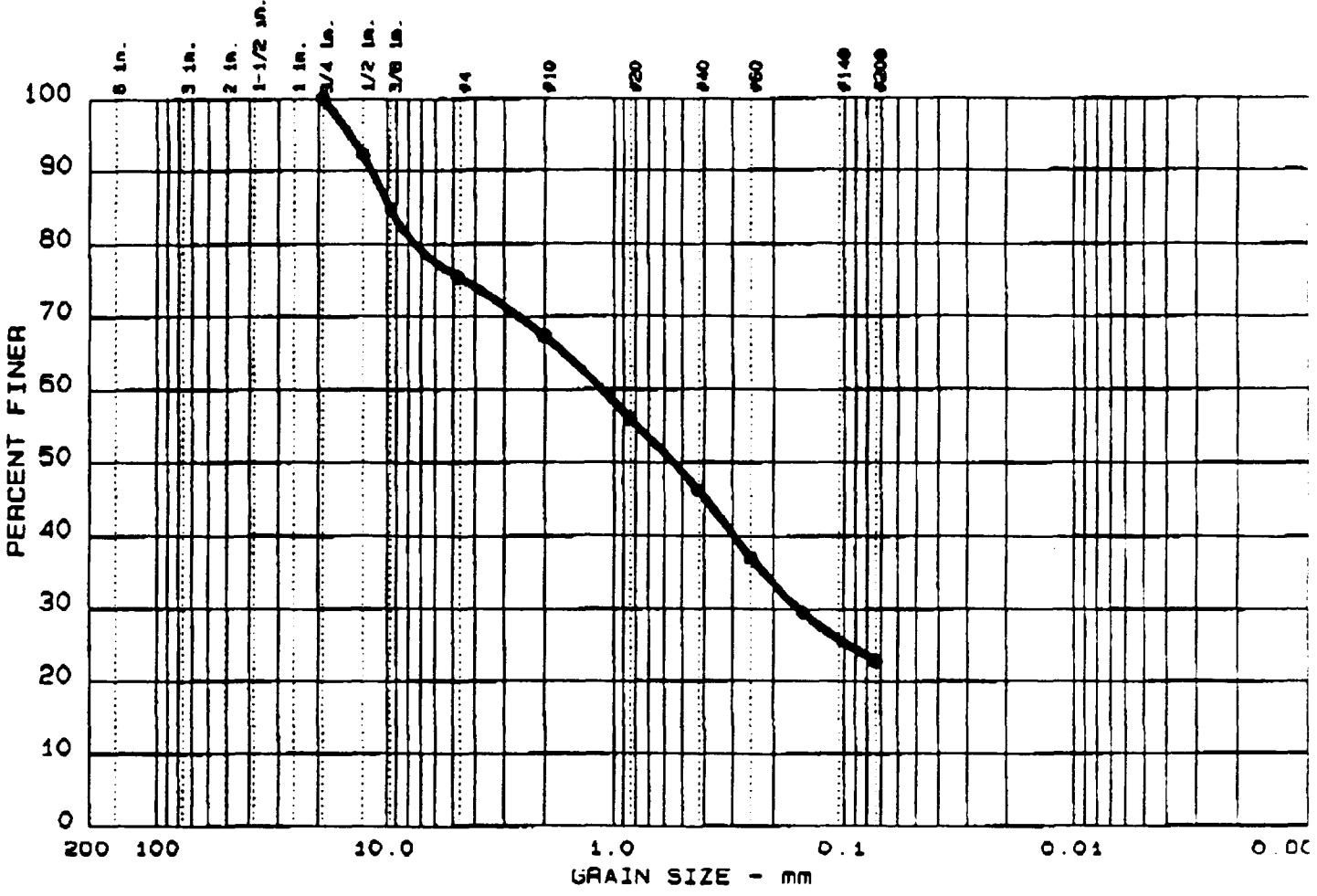
LAB NO. 1429.047

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	15	0.0	24.6	52.6	22.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			9.65	1.13	0.54	0.156				

MATERIAL DESCRIPTION	USCS	AASHTO
● DRK GREY SAND, Some Gravel & Fines		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 4-4

Date: OCTOBER 6, 1992

Remarks:

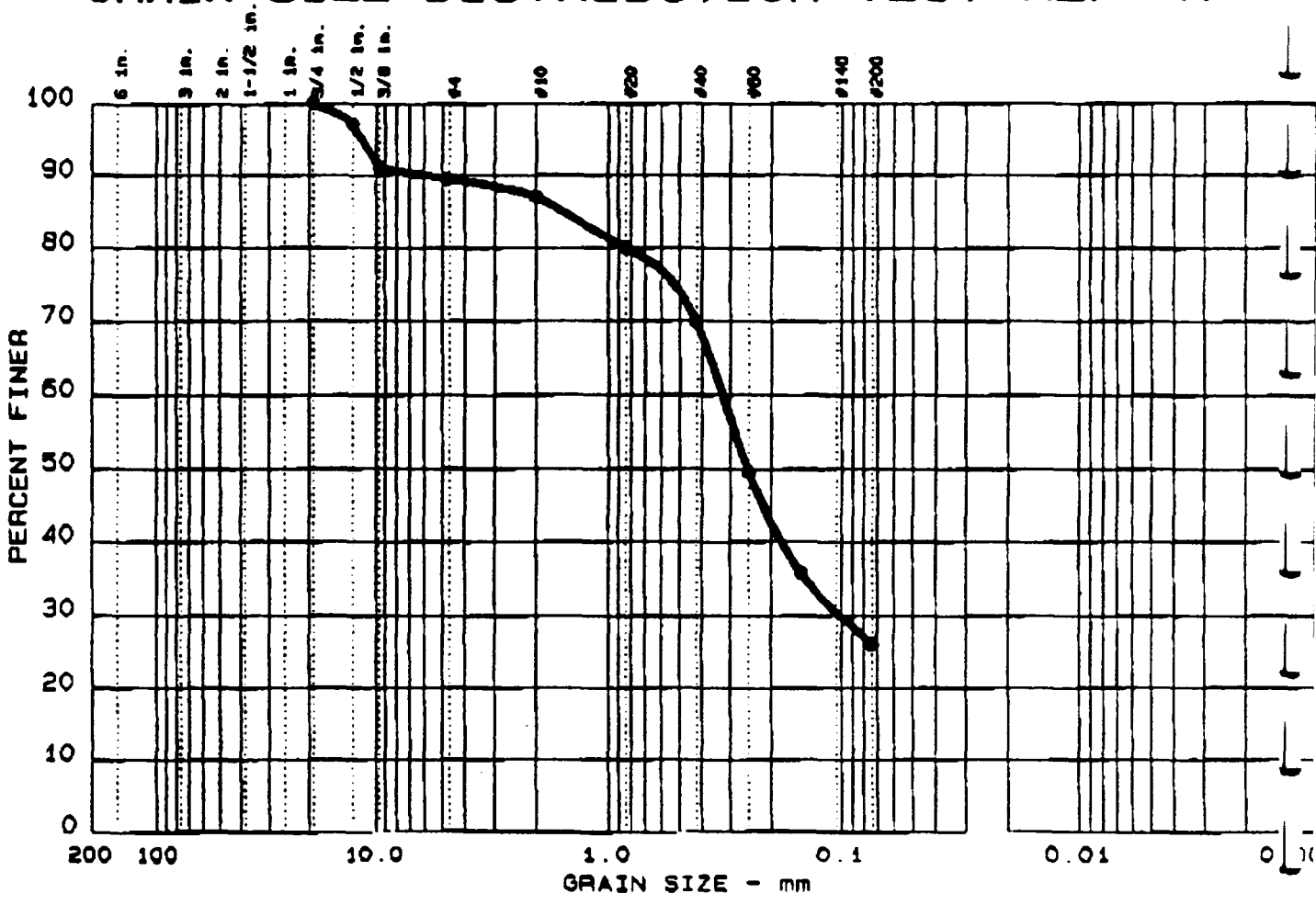
LAB NO. 1429.046

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLA
●	14	0.0	10.5	63.5	26.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C
●			1.53	0.32	0.25	0.102				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SAND, Some Fines, Little Gravel		

Project No.: STA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 4-3

Date: OCTOBER 6, 1992

Remarks:

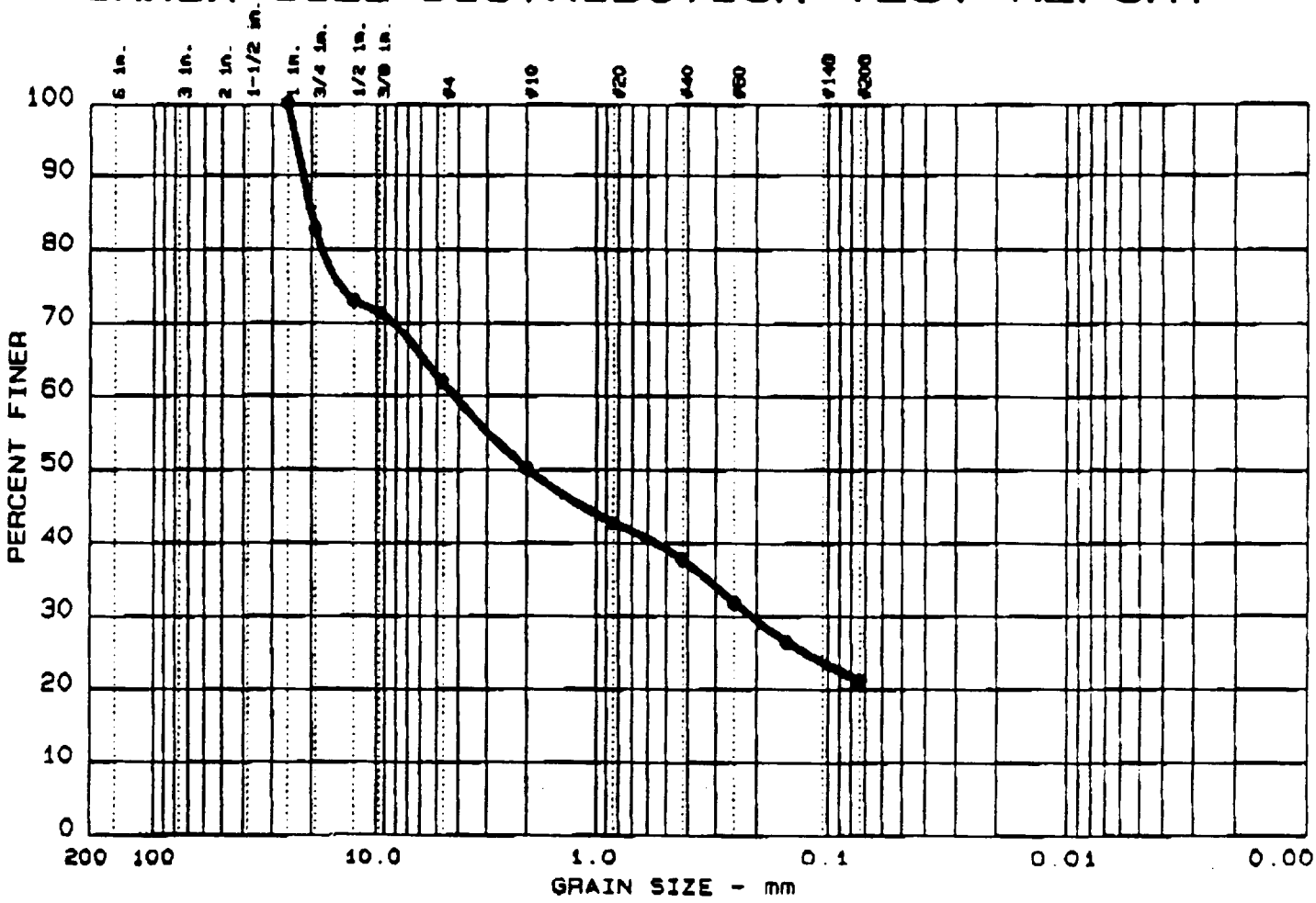
LAB NO. 1429.045

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	13	0.0	38.1	40.7	21.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			19.88	4.20	1.99	0.213				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SAND AND GRAVEL, Some Fines, ORGANICS		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 3-5

Date: OCTOBER 6, 1992

Remarks:

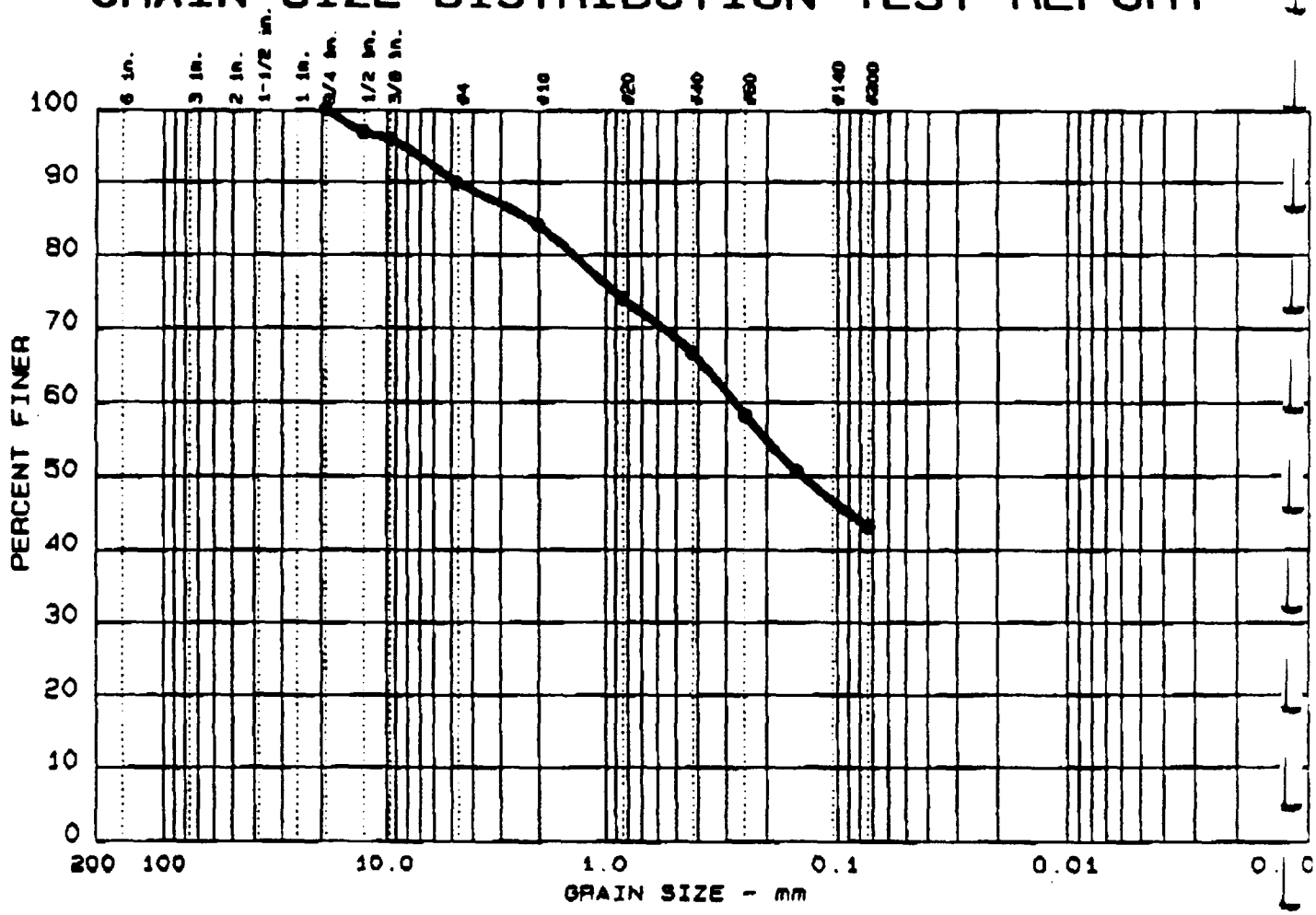
LAB NO. 1429.044

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	10.0	47.0	43.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			2.24	0.28	0.14					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SAND AND FINES, Little Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 3-1

Date: OCTOBER 6, 1992

Remarks:

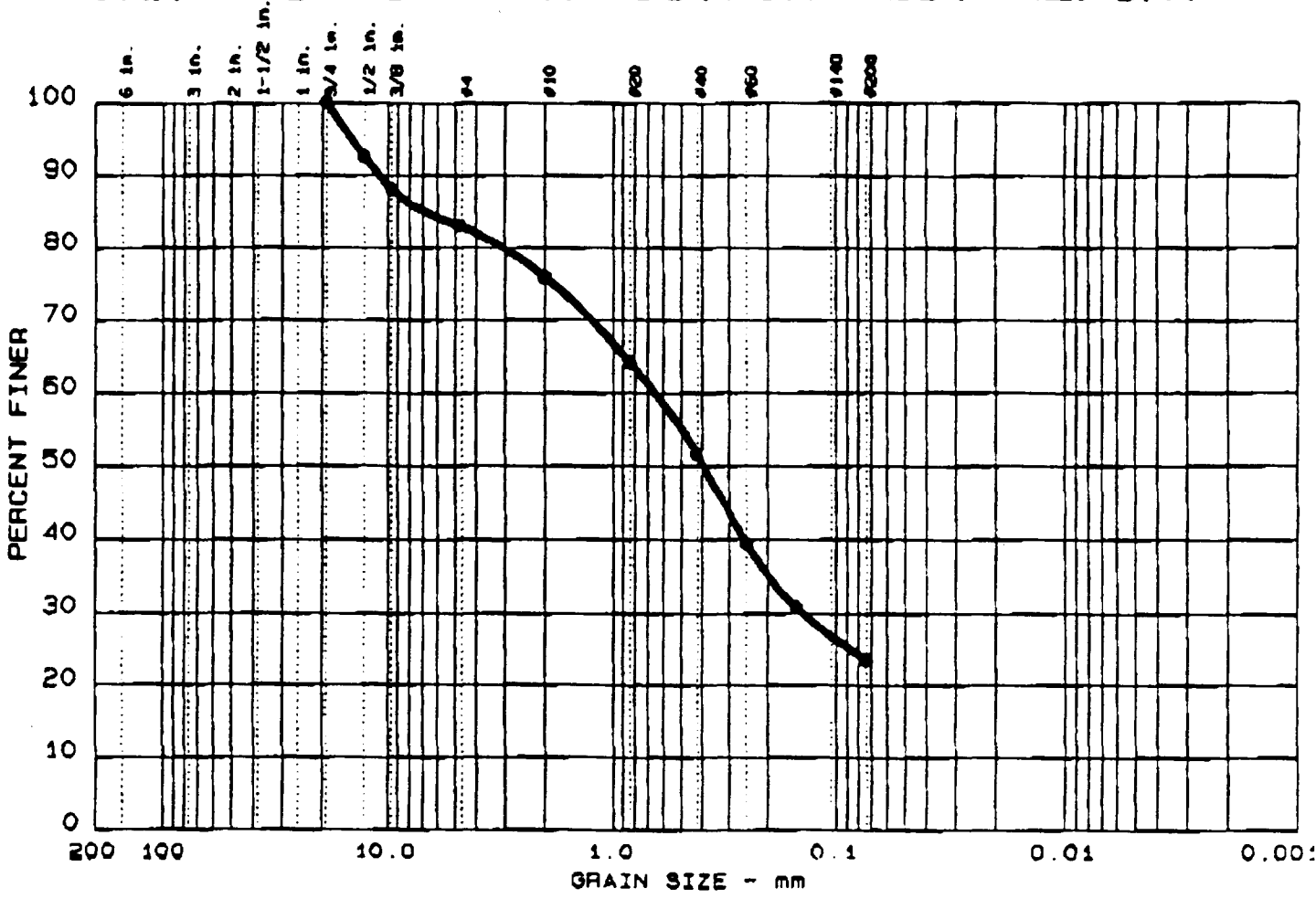
LAB NO. 1429.043

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	17.0	59.5	23.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			6.68	0.65	0.39	0.140				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SAND, Some Fines, Ltle Gravel, ORGANICS		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 2-6

Date: OCTOBER 6, 1992

Remarks:

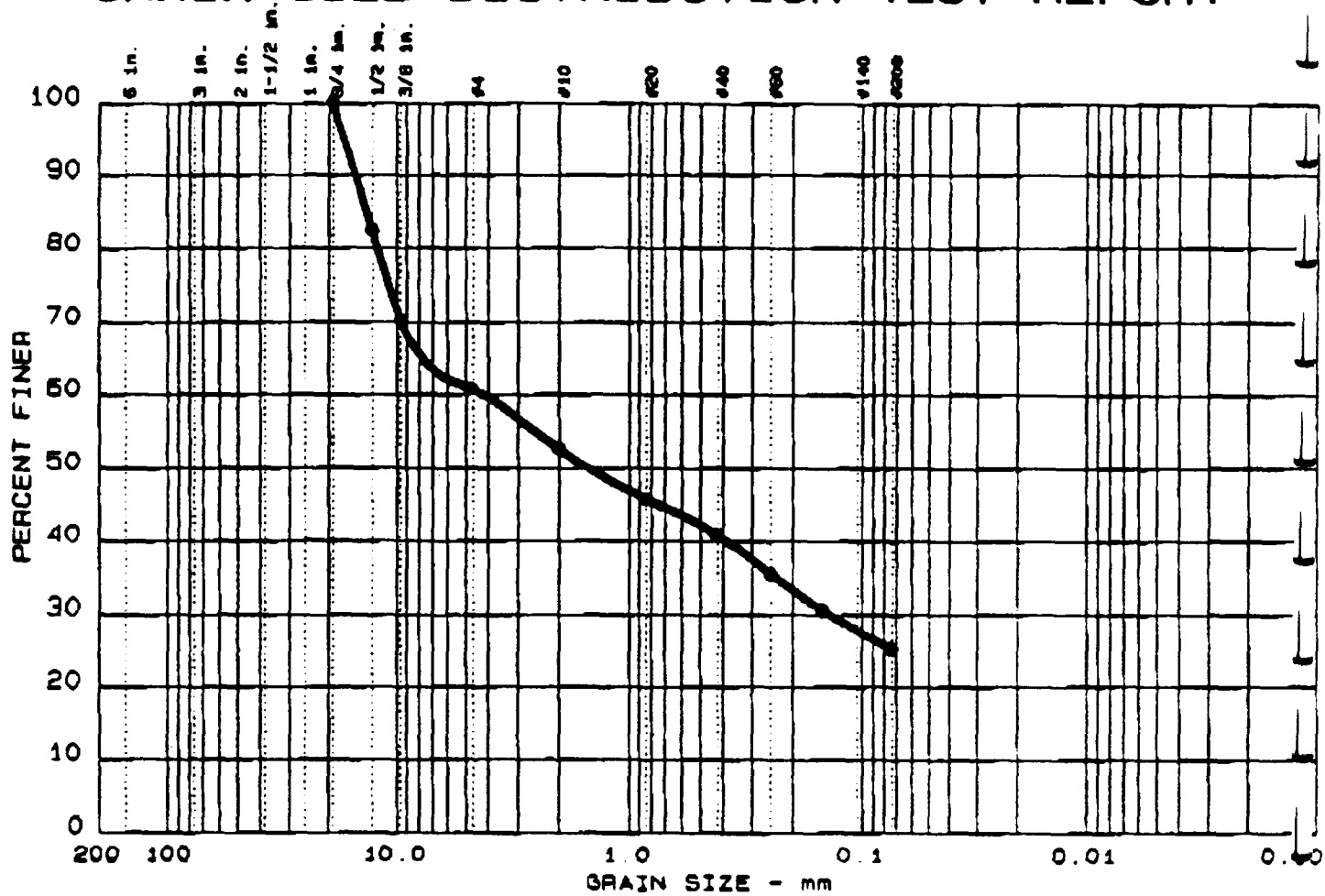
LAB NO. 1429.042

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	10	0.0	39.2	35.5	25.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C
●			13.43	4.20	1.51	0.139				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN GRAVEL AND SAND, Some Fines, ORGANICS		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 2-6

Date: OCTOBER 6, 1992

Remarks:

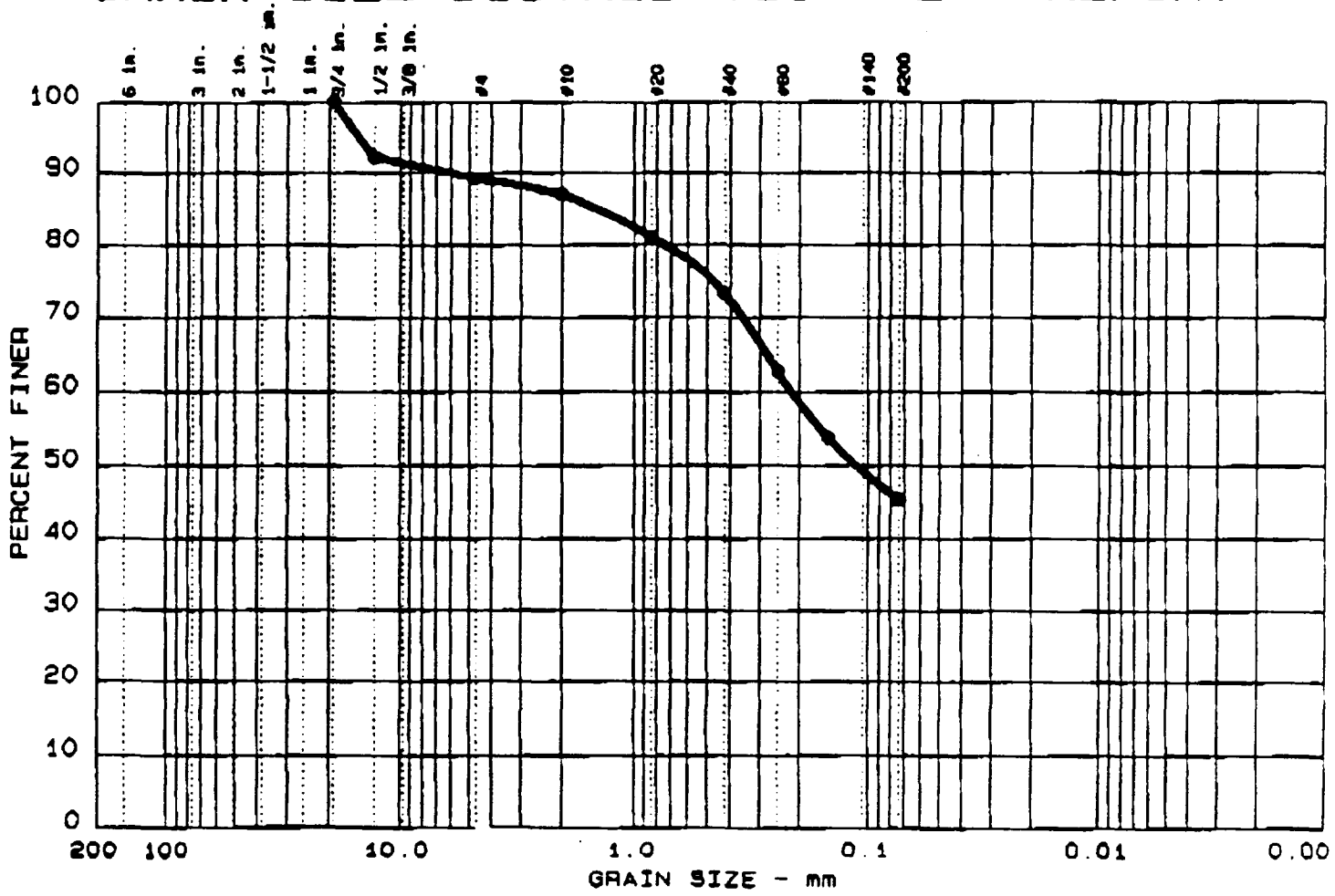
LAB NO. 1429.041

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	B	0.0	10.7	44.0	45.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.41	0.22	0.11					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FINES AND SAND, Little Gravel, ORGANICS		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 2-4

Date: OCTOBER 6, 1992

Remarks:

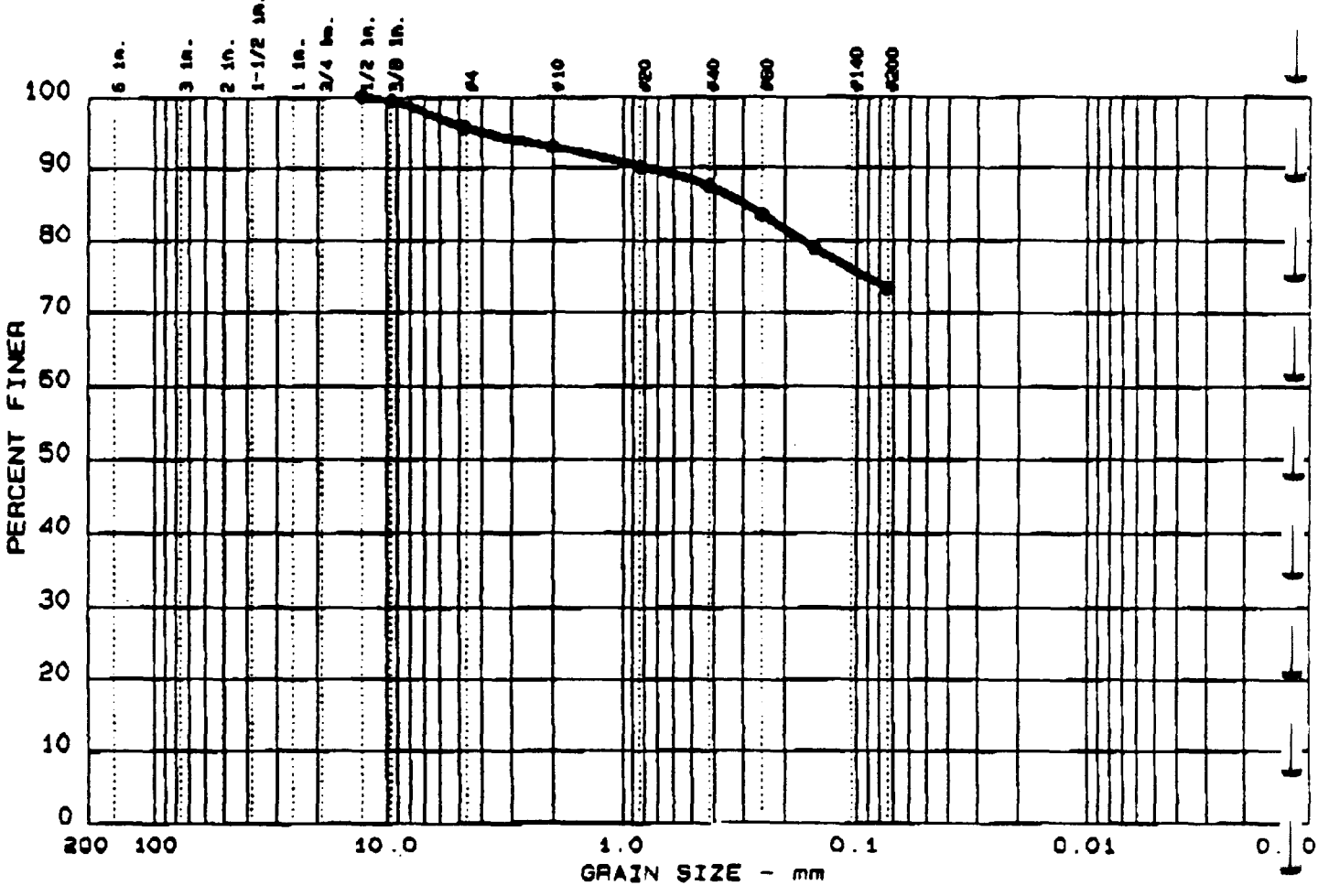
LAB NO. 1429.040

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	B	0.0	4.3	22.3	73.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.30							

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FINES, Some Sand, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 2-2

Date: OCTOBER 6, 1992

Remarks:

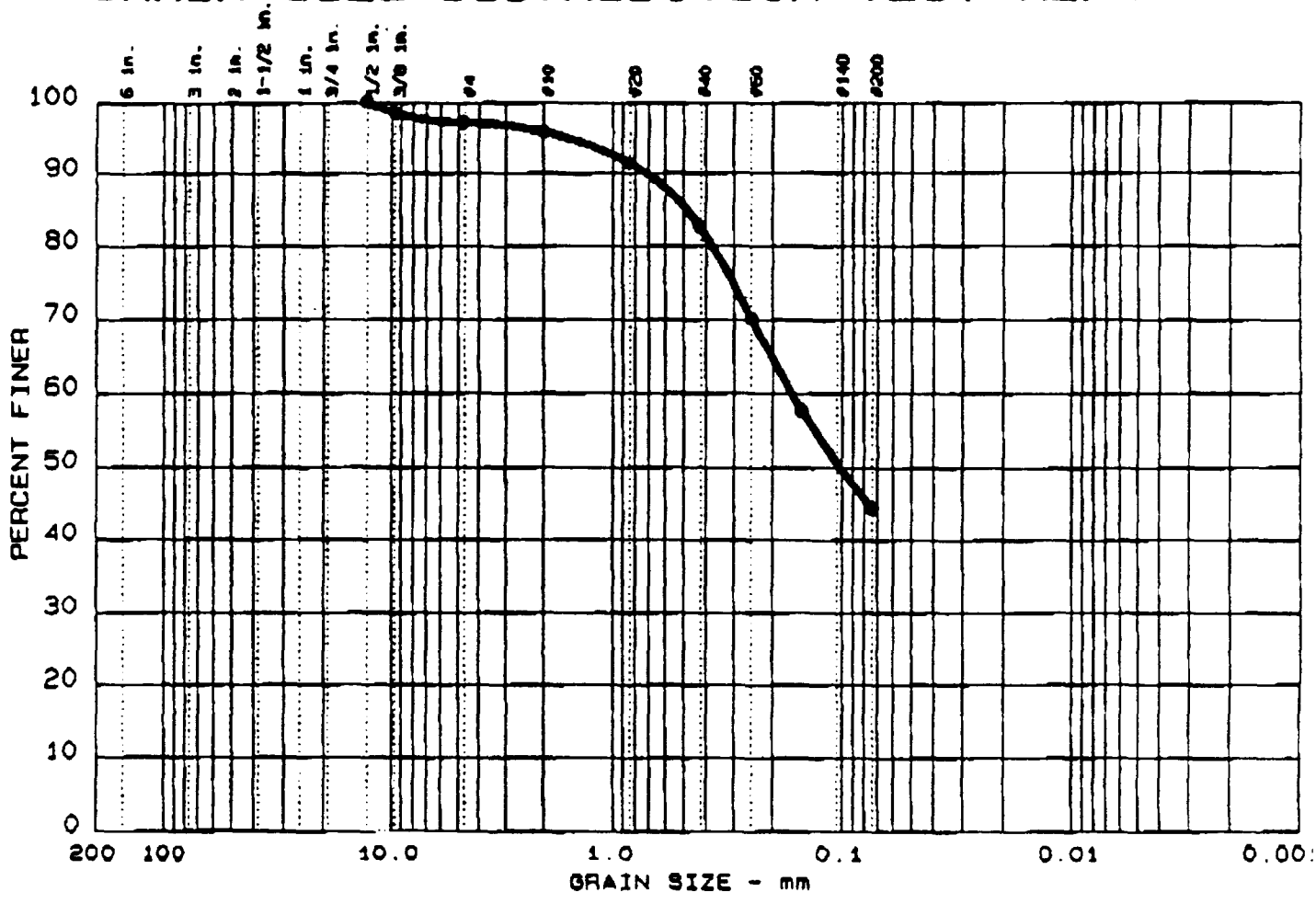
LAB NO. 1429.038

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	7	0.0	2.8	52.9	44.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.48	0.16	0.10					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SAND AND FINES, trace gravel, ORGANICS		

Project No.: BTA-82-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 1-9

Date: OCTOBER 6, 1982

Remarks:

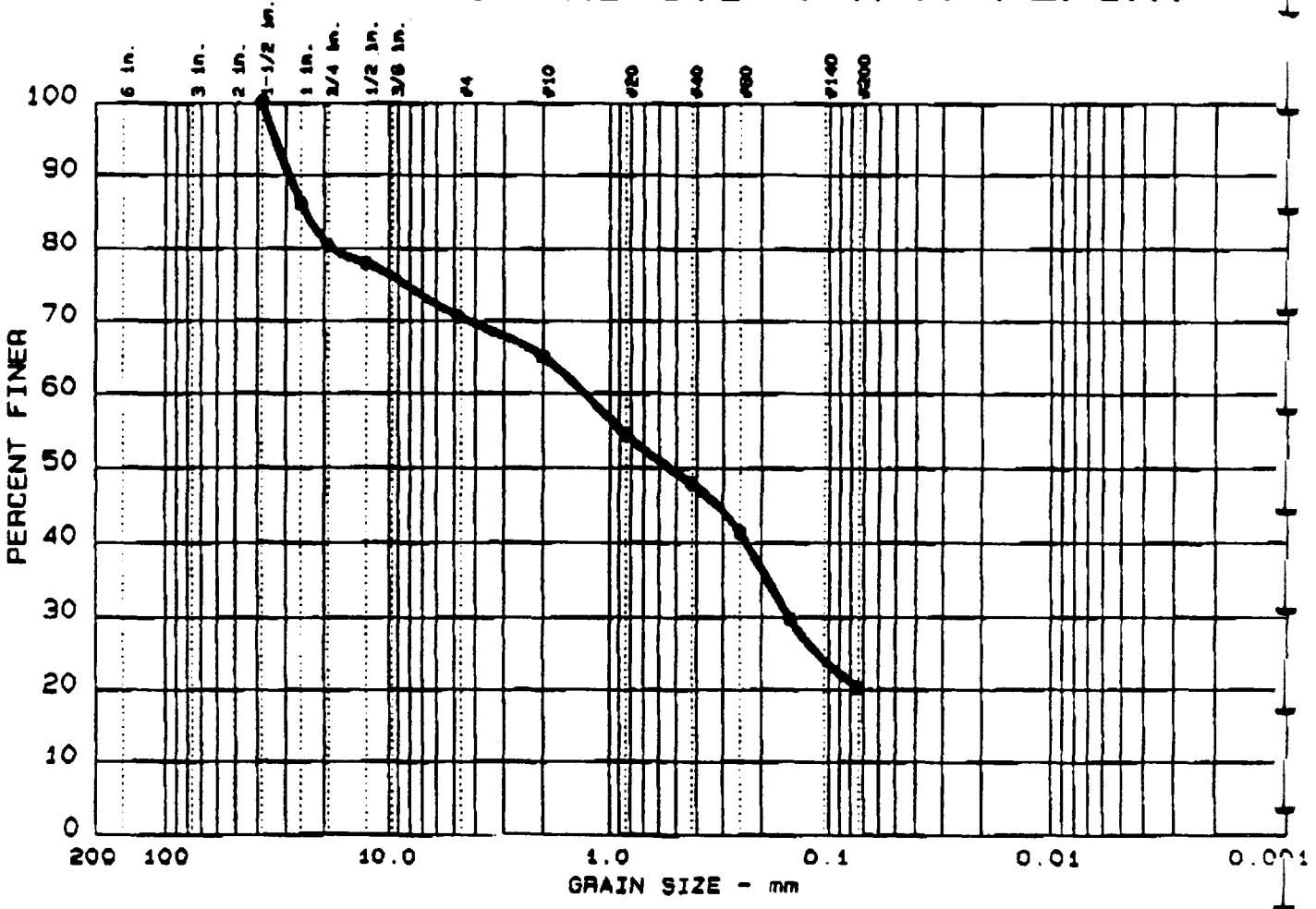
LAB NO. 1429.038

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	6	0.0	29.5	50.3	20.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			24.27	1.30	0.54	0.151				

MATERIAL DESCRIPTION	USCS	AASHTO
● BLACK SAND, Some Gravel & Fines		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: GS 1-2

Date: OCTOBER 6, 1992

Remarks:

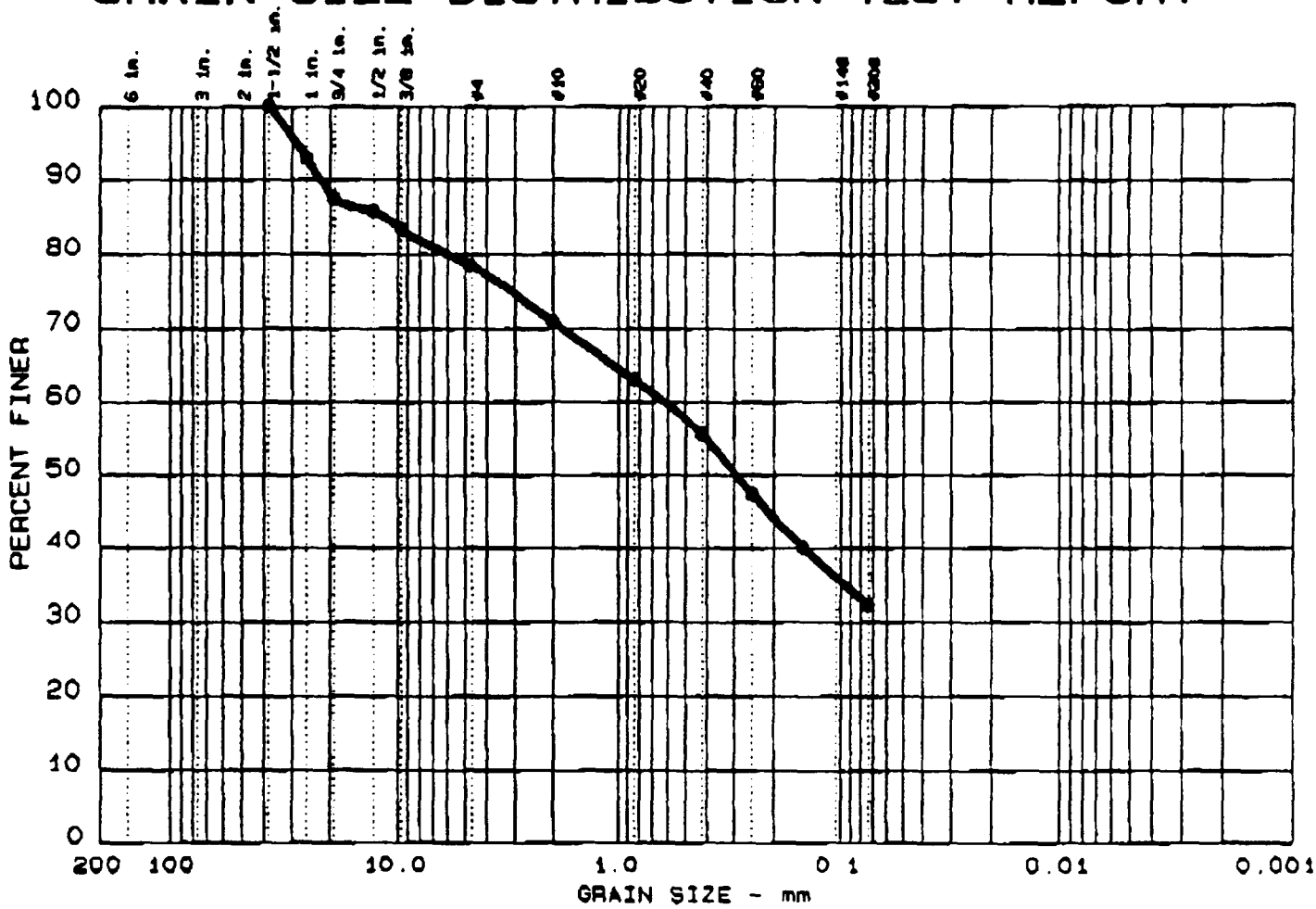
LAB NO. 1429.037

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	S	0.0	21.4	46.4	32.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			11.22	0.62	0.29					

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SAND, Some Fines & Gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: B-5 / S-3 / 4'- 6'

Date: OCTOBER 6, 1992

Remarks:

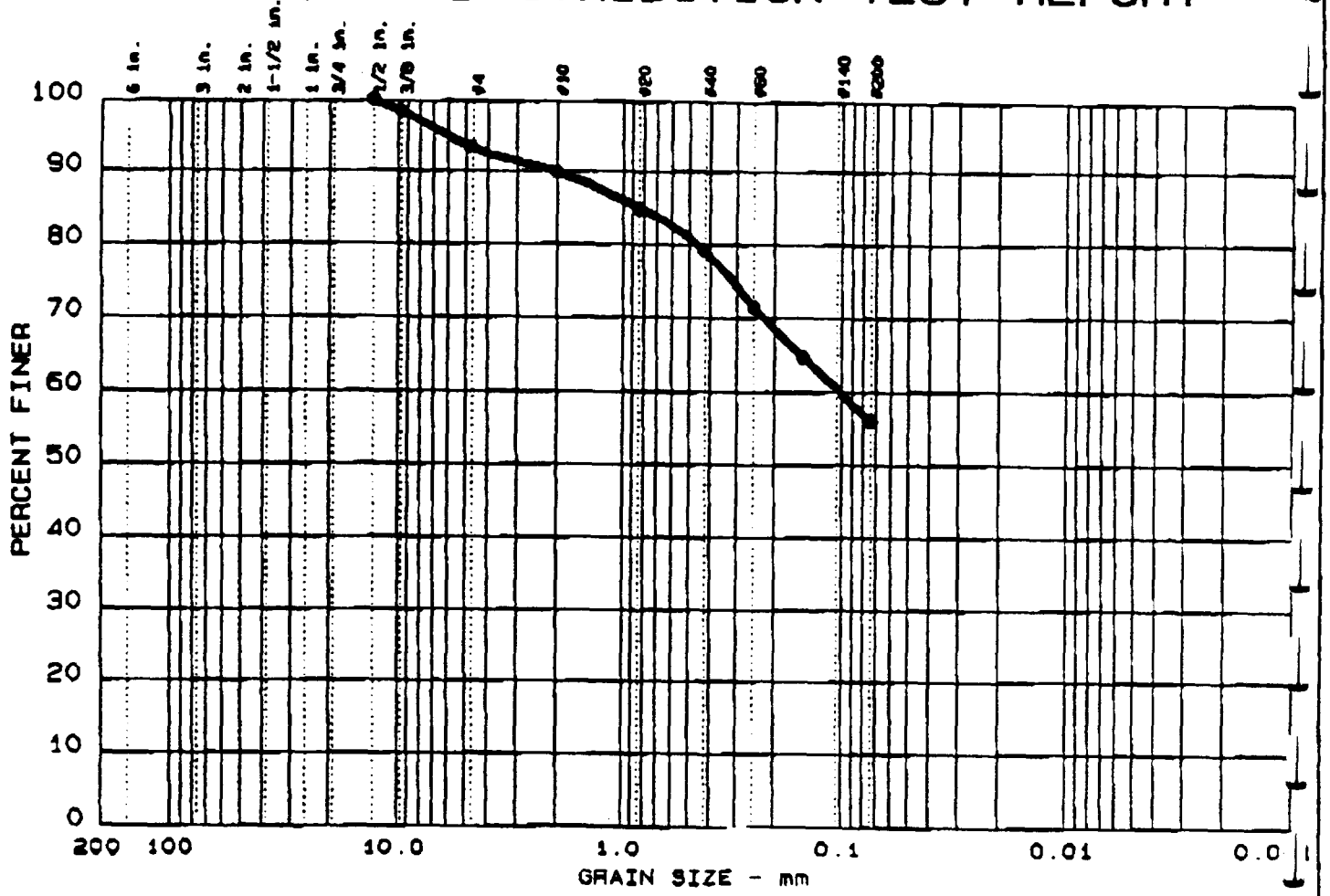
LAB NO. 1429.030

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	6.6	37.4	56.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.84	0.10						

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FINES AND SAND, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: B-4 / S-2 / 2'- 4'

Date: OCTOBER 6, 1992

Remarks:

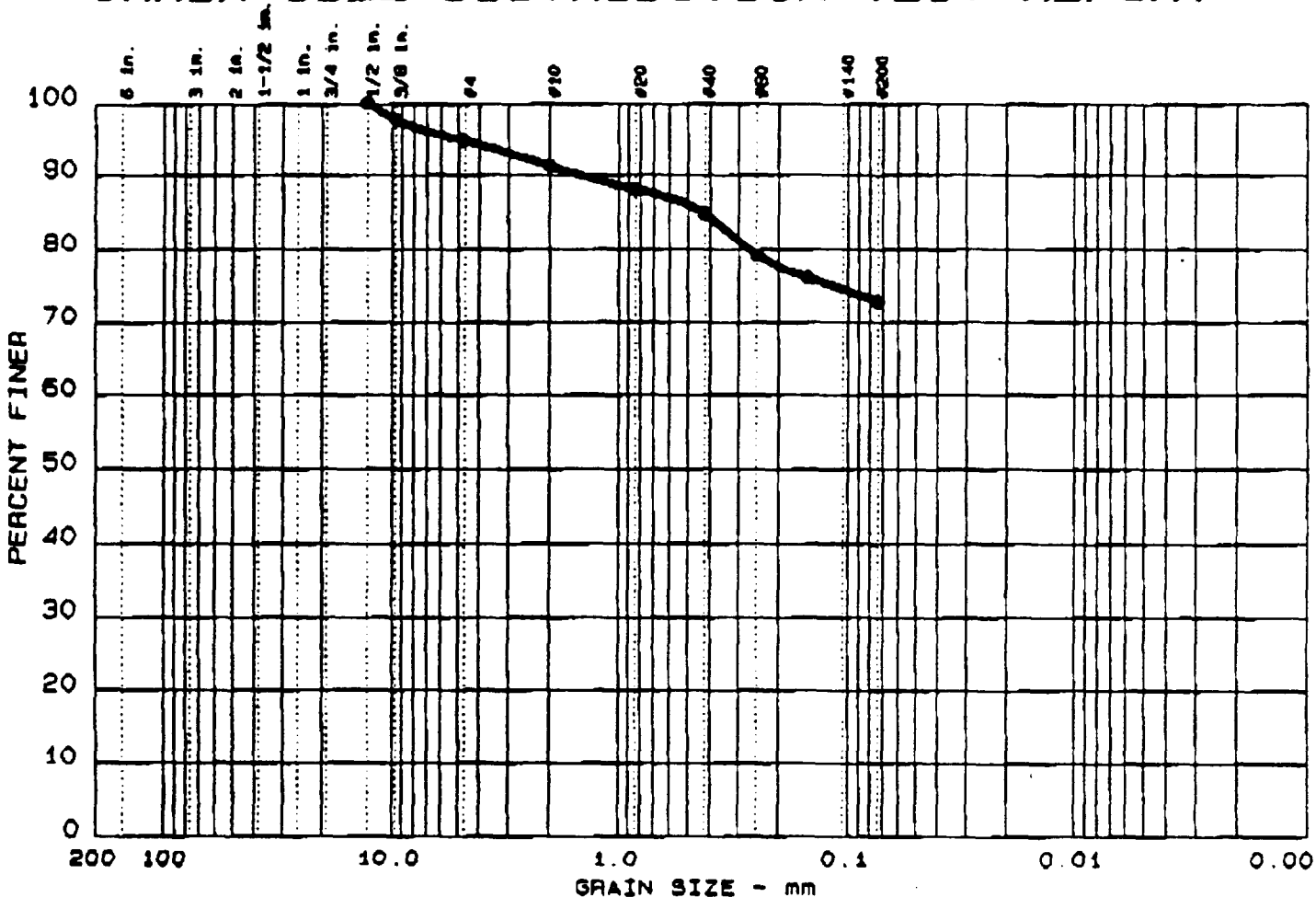
LAB NO. 1428.020

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	5.1	22.1	72.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.43							

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FINES, Some Sand, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: B-3 / S-2 / 2'- 4'

Date: OCTOBER 6, 1992

Remarks:

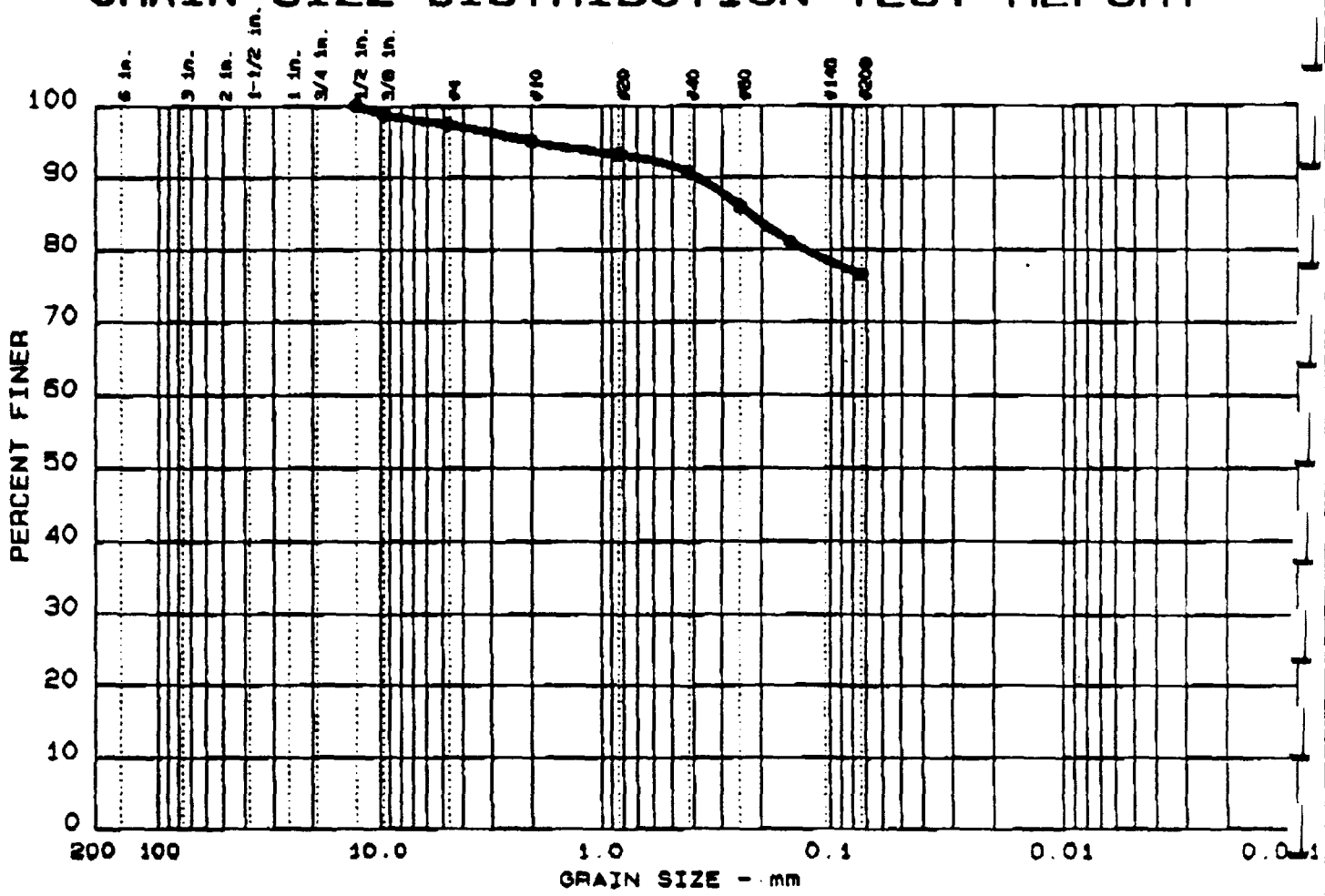
LAB NO. 1429.014

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	2.6	20.9	76.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.23							

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FINES, Some Sand, trace gravel		

Project No.: BTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: B-2 / S-5 / 8'- 10'

Date: OCTOBER 6, 1992

Remarks:

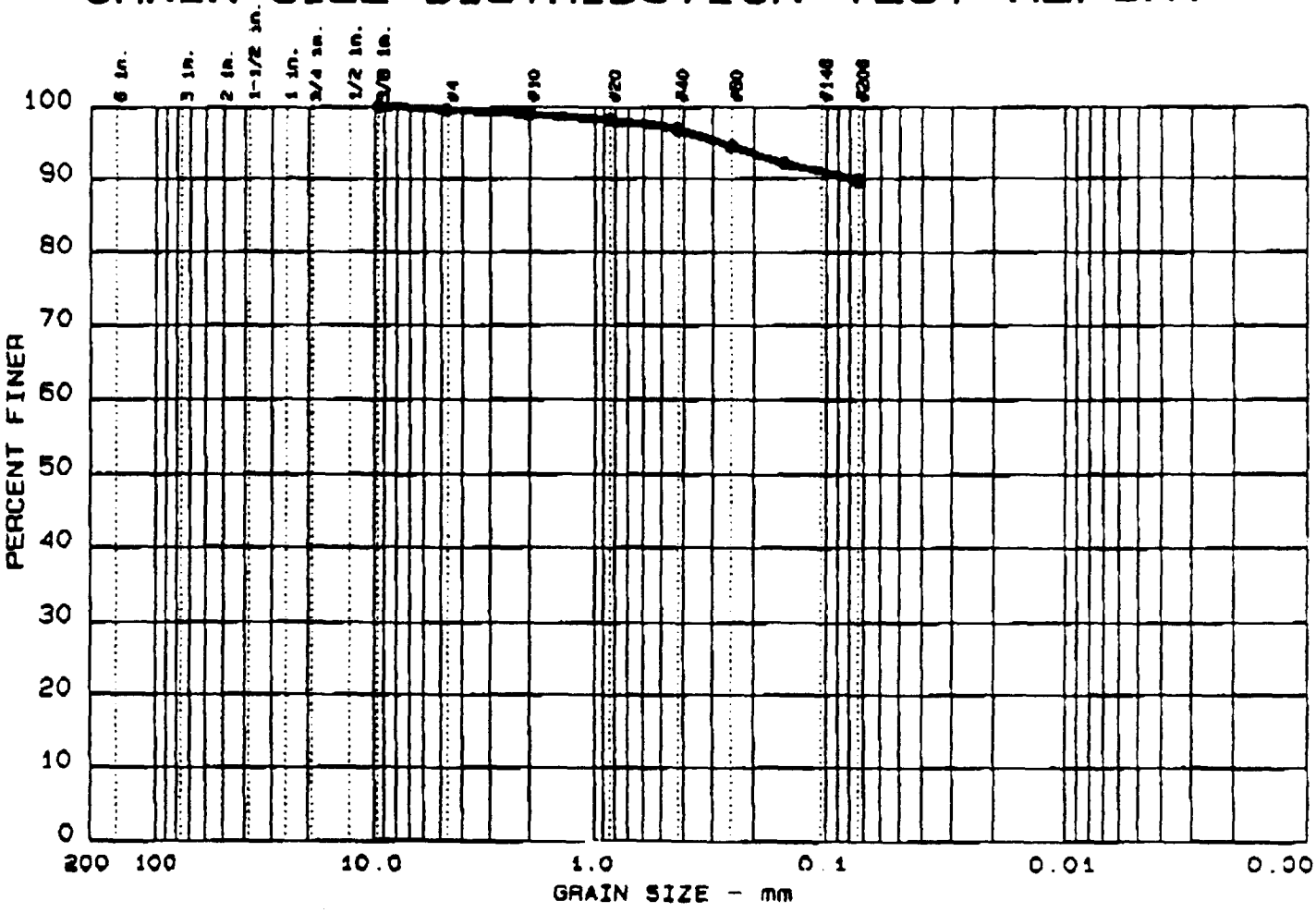
LAB NO. 1429.011

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	0.4	9.9	89.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_U
●										

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN FINES, trace sand & gravel		

Project No.: GTA-92-205
Project: SUMMIT NATIONAL SUPERFUND SITE
● Location: B-1 / S-4 / 6'- 8'

Date: OCTOBER 6, 1992

Remarks:

LAB NO. 1429.004

GRAIN SIZE DISTRIBUTION TEST REPORT

EMPIRE SOILS INVESTIGATIONS, INC

Figure No. 1